THE

SCIENCE AND PRACTICE OF SURGERY.

I.

THE

SCIENCE AND PRACTICE

OF

SURGERY:

INCLUDING SPECIAL CHAPTERS BY DIFFERENT AUTHORS.

WITH NINE HUNDRED AND SIXTY-NINE ILLUSTRATIONS ON WOOD,
MOSTLY NEW AND ORIGINAL.

BY

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SECOND EDITION, IN TWO VOLUMES,

REVISED OR RE-WRITTEN, AND MUCH ENLARGED THROUGHOUT.

VOL. I.

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PREFACE TO THE SECOND EDITION.

In offering to the Profession a new edition of this work, I have endeavoured to render it a more trustworthy and complete representation of Surgery, in its widest acceptation; although within the limits of a compendious Text-book. And, while writing to meet the requirements and varied circumstances of the Surgeon in the course of practice, I have thus also fully maintained the educational character of the Student in Surgery.

Accordingly, the whole of the Text has been thoroughly revised, or in many parts rewritten; and a large amount of new matter is introduced, extending to five hundred and thirty-two pages beyond the previous edition—exclusive of Index. Not a chapter, and scarcely even a page, has been left without some such alteration or addition, conformably with the state of Surgery, both in its Science and Practice. So general and important are these changes throughout, that the present edition may be rgarded as a new work.

Pursuing the original design of this Surgery, I have sought to supply a sound and enlarged exposition of Pathology, in the various forms of Injury and Disease, respecting also their diagnosis, their causes, courses, and prognosis; with a full consideration of their Treatment, as *derived* from all this pathological knowledge, and supplemented by the resources of experience—especially in regard to the appropriate Surgical Operations and Manipulations, the plan and performance of which are carefully described in detail. The various kinds of Surgical Apparatus are noticed, and their modes of application explained.

Having regard to the intimate relation of Anatomy—as well as Pathology—to the Practice of Surgery, whether in the diagnosis of morbid conditions or their treatment by Operations, I have introduced the Practical Anatomy of various important parts, in connection with their injuries and diseases; *e.g.* of the Arteries, with reference to Ligature; of the region or parts concerned, in relation to Herniæ; and of the Bladder, Prostate Gland, and Urethra, as bearing on the Surgery of these organs. Physiology is interwoven, occasionally, with the Pathology of morbid conditions.

The arrangement of the work is simple and comprehensive. By a condensed view of Modern Surgery, as a Science and an Art, the Student will gain an elementary knowledge of both. Then follows the primary division into General and Special Pathology; the one comprising Diseases of Nutrition, of the Blood, and of the Nervous System; the other being a Histological association of Diseases, as affecting Textures and Textural Systems; and Topographical, as pertaining to Organs and Regions. Beginning with the Head, and proceeding downwards in the Body, this latter subdivision includes every branch of Surgical Practice.

Some subjects to which, for many years, I have given particular attention, *e.g.* Diseases of the Joints,—chiefly with relation to their treatment by Excisional Surgery,—and Diseases of the Genito-Urinary Organs, may have been dwelt upon more fully than others, yet not with undue prominence as parts of a whole.

For the vast accumulation of facts within the range of modern Surgery, very many sources of information—whether in the form of Special Treatises, Monographs, Transactions of Societies, Hospital Reports, Medical Journals, etc., have necessarily been referred to, not omitting some of the more important researches with which our American brethren and foreign *confrères* have enriched Surgical literature. Indeed, it would be almost impossible to name individually all those to whom by their published writings I am thus indebted. But I trust that original observations are always duly acknowledged in the Text,—supplemented by the Index. My own pathological observations and surgical experiences, interspersed throughout the Text, are not collected together in the Index.

In certain special departments of experience, this new edition has the advantage of original contributions from authorities on their respective subjects. The chapter on "Injuries and Diseases

of the Eye" has been revised and considerably enlarged by Mr. Power, senior Ophthalmic Surgeon to St. Bartholomew's Hospital; the chapter on the "Ear" is entirely due to Mr. Purves, Aural Surgeon to Guy's Hospital; and that on "Dental Surgery" to Mr. Charles S. Tomes. "Diseases of the Throat and Larynx" are represented by the large experience of Dr. Morell Mackenzie; and, in like manner, Mr. William Adams has dealt with "Deformities," as including Orthopœdic Surgery, and Lateral Curvature of the Spine. Professor Erasmus Wilson has written a chapter on "Diseases of the Skin," presenting an original view of Dermatology, reclaimed from the barren technicalities of a speciality, and cultivated in the light of general pathology and therapeutics. The concluding chapter, on "Diseases of the Female Genital Organs," has been revised and extended by Dr. Robert Barnes. I have also to thank Dr. Mahomed for having communicated a special description of the "Sphygmograph" and its applications in various clinical investigations. Nor should I omit to mention the kindly assistance I have had from my colleague, Mr. William Rose, by his review of "Cleft Palate and its Treatment."

These valuable revisions and additions cannot fail to render this work a more complete expression of British Surgery, and more generally useful.

Eight hundred and forty-nine *new* wood engravings have been introduced, partly replacing those which have been withdrawn, partly additional, making a total of nine hundred and sixty-nine illustrations—as compared with four hundred and seventy in the previous edition. The great majority have been selected, by permission, from the rich collections of pathological specimens in the Royal College of Surgeons, and most of the Hospitals of this metropolis; St. Bartholomew's, St. Thomas's, St. George's, Guy's, University College, London, Middlesex, King's College, St. Mary's, and the Royal Free Hospitals. My acknowledgments of all these *original* illustrations from nature are severally specified by foot-notes throughout the work; and for the information of those readers who may be desirous of acquiring yet further knowledge of this series, some descriptive account of the specimen of injury or disease, and clinical history of the case, are not unfrequently appended from the Museum catalogues in each Hospital, thus so as not to intercept the continuity of the text.

In my arduous selection of appropriate specimens from collec-

tions so large and various, the Curators of these Museums have enhanced the value of the work by directing my attention to the more noteworthy cases; and here, perhaps, I would thank especially Mr. Charles Stewart, of St. Thomas's Hospital, for thus having given his aid.

My own illustrations, amounting to about one hundred and sixteen, relate partly to microscopic specimens, but principally to clinical cases, and the operations of Surgery,—in their various stages, and their results. They are mostly indicated by footnotes, but many other engravings which have no reference whatever have been designed by myself.

To the Wood Engraver and the Draughtsman, Messrs. George Evans and Son, great credit is due for the finished skill each has displayed in the exercise of his art; limited only by my own particular request to make the engravings faithfully effective, rather than elaborate.

Lastly, the Index has been altered and enlarged, chiefly with reference to the general transformation which the work has undergone. And, for the convenience of use, this edition is published in Two Volumes, both in this country and in America.

FREDERICK JAMES GANT.

CONNAUGHT SQUARE, LONDON, W.
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THE

SCIENCE AND PRACTICE OF SURGERY.

INTRODUCTION.

MODERN SURGERY AS A SCIENCE AND AN ART.

SURGERY is that primary division of Medicine which has for its object the cure or the relief of morbid conditions of the body, in a corresponding division of Pathology. But the line of separation is arbitrary, conventional, and indefinite.

Firstly, as to the nature of the morbid conditions, or Surgical Pathology. All injuries, malformations, and deformities, congenital and acquired, and all diseases affecting external parts, are usually allotted to Surgery.

Secondly, in respect to the kind of Treatment, or the means of cure or relief. Surgery comprises all operations effected by instruments, manipulative procedures, and the employment of mechanical appliances; but it also has recourse to the administration of medicinal agents, and to hygienic measures.

Surgical Pathology is both General and Special. *General* Surgical Pathology comprises the different forms of Injury and Disease which are common to all parts of the body; and these morbid conditions, illustrating the laws of Pathology, are the primary source of guidance in all surgical practice.

As general forms of Injury—Wounds, Fractures, Dislocations, and Aneurisms, may be naturally associated; and especially in virtue of the various laws whereby these lesions undergo Reparation, through processes which are more or less clearly referable to modifications of healthy Nutrition. But this department will be more conveniently considered in connection with the particular Textures injured. As general conditions of Disease—Inflammation, Morbid Growths or Tumours, and Degenerations, may also be referred to modifications of Nutrition; namely, to Accelerated, to Reproductive, and to Declining Nutrition; while Ulceration, and Gangrene or Mortification, represent textural Death. Certain Blood diseases, Contagious diseases, and general diseases of the Nervous System, further illustrate the laws of Pathology.

Special Surgical Pathology may be subdivided into injuries and diseases of the Textures and Textural Systems—*e.g.*, the Skin and the Vascular System, and those which, with malformations, pertain to Organs and Regions—*e.g.*, the Organs of Special Sense, and of Reproduction. The latter subdivision, as a mode of classification, makes no pretension to any scientific distinctions; it is simply an anatomical or a topographical arrangement of morbid conditions.

In relation to Anatomy and Physiology, the truth has become fully recognized that disease is not an independent entity in the body, as if foreign to the healthy organism; but that Pathology represents only *modes* of living and modes of dying; although the line of transition from healthy to diseased states, in regard to structure and function, is indefinite, and variable in the history of every individual existence.

But the student must ascend to yet higher ground than this in his contemplation of modern Surgery as a Science. Animated, or rather inspired, by a far more comprehensive spirit of inquiry, than that which relates to the human species alone, John Hunter's view of Pathology was an extension of a colossal Physiology, and a corresponding Anatomy, embracing the whole living creation. It was from this vast range of Biological Science that Hunter sought to interpret the structural conditions and the phenomena of life in any one species; and thus, for example, to enlighten our otherwise isolated knowledge of *human* anatomy, physiology, and pathology;—of man, structurally and functionally, in the states of health and disease. From this elevated point of view we must look, to justly appreciate the Hunterian conception, and its influence on the British School of Surgery. Subsequently, it became apparent how largely and intimately the Sciences of Physics and Chemistry enter into this system of Biology; and thence we might trace the grand contributions of the Continental Schools, more especially, and particularly in Germany and France. Here, then, we discern the three primary elements of modern Scientific Medicine.

The more immediate sense, however, in which Modern Surgery claims the rank of a Science, is by virtue of the progress of Pathology; —of that Science which teaches the nature of all the abnormal or diseased changes which the living organism is liable to undergo; the causes of such conditions; their vital course, terminations, and consequences. In this country, the section of Pathology which relates to Surgery first assumed a representative position, mainly by the labours of Sir James Paget, as recorded in his renowned "Lectures," and "The Pathological Catalogue of the Museum of the Royal College of Surgeons;" while, in Germany particularly, Surgical Pathology has been developed chiefly by the genius of Virchow and Billroth.

Regarded as a scientific Art, the Practice of Surgery has a corresponding derivation from Science.

The *pathology* of injuries and diseases, taken *individually*, embraces: (1) the particular structural condition presented, its signs and symptoms, and its diagnosis or detection and discrimination from other conditions; (2) its cause or causes, or etiology, and the effects of the morbid condition itself as a cause; (3) its course, terminations, and consequences, and the prognosis or foreknowledge of these events.

The *treatment* in any case may be operative, or medicinal, or both.

The comparative importance of the three divisions of investigation respecting injury or disease, and of the whole of this pathological knowledge in relation to treatment, may be estimated as follows:—

1. *Diagnosis* is primarily necessary, in order to discover the particular structural condition, and extent of the injury or disease, when capable of being so defined, and its distinction from other conditions.

To make this discovery, the concomitant effects of the morbid condition are taken as *Signs* or *Symptoms* of its existence. The relative diagnostic value of such evidence will depend upon, and vary with, its more or less constant and exclusive conjunction with the morbid condition. Accordingly, a Symptom, or as the etymological meaning of this term would express, a coincidence or co-occurrence, is less characteristic and distinctive than a Sign, the latter being that by which anything is known or recognized. Any sign peculiar to a morbid condition is named *pathognomonic.* But the *co-existence*, or at least the *consecutiveness* of symptoms,—any one of which would be equivocal, if taken by itself,—constitutes a weight of evidence, *greater in the aggregate* than that which the *several* items of evidence would represent by being merely added together. This augmentation of collective evidence is by virtue of a law of mental association, and not a property of numbers or of any kind of magnitude. If in one balance of a weighing scale were placed a weight of five pounds, and in the other a weight of one pound, the balance is as five to one. Other weights of one pound each being successively added to the one-pound scale, would severally tend to equalize the balance; and five such weights would equal a five-pound weight; but five separate pounds weight, so to speak, of evidence, taken together, preponderate over a single five-pound weight of adverse evidence.

In the diagnosis of the different general forms of Injury—already mentioned—the discrimination of Fracture from Dislocation and other conditions, affords an instructive illustration of the equivocal value of signs and symptoms, taken singly and separately, but of their conclusiveness, when considered collectively, in determining the diagnosis of this injury.

Let me first briefly enumerate the signs and symptoms of Fracture, say in either limb; and then proceed to the Diagnosis; as hereafter stated in the course of this work. Fracture is attended with *mobility* of the broken portions of bone, and *crepitation*, a rough grating sensation, felt and heard when the broken surfaces are gently moved in contact. Usually the *normal outline of the limb* is altered, by the displacement of the fractured ends of bone, a deformity which the experienced eye will frequently recognize at a glance; and there is more or less elevation or depression, also occasioned by the displacement, prior to swelling, at the immediate *seat* of fracture. *Shortening of the limb*, in some degree, takes place, when one of the single long bones is broken; this sign arising from the involuntary contraction of the muscles which act on the lower fragment. Lastly, pain, and inability to use the limb, are *functional* symptoms, which the patient experiences, and which may be included in the evidence obtained by the surgeon in his examination.

Proceeding to analyze the *diagnostic* value of these signs and symptoms, as the evidence of Fracture, they may *severally* be estimated as

follows :—The pain may be insignificant at first, before swelling supervenes; and the power of motion is retained in the case of impacted fracture, or where one only of two companion bones is broken, the other acting as a splint. With fracture of the radius, in the forearm; or of the fibula, in the leg; the ulna or the tibia thus preserves some of the motions of the limb, although the special functions of either broken bone are lost. But if the *functional symptoms* of pain and loss of voluntary power attend the injury, they may each arise from other causes than fracture; as from dislocation, a bruise, or an attack of rheumatism, which thus far may simulate fracture. The *physical signs* of Fracture, taken singly, are sometimes absent. Mobility, in the case of impacted fracture; crepitation, if there be much displacement, or if soft tissue of any kind intervene between the fragments, or if some days have elapsed since the accident. The deformity of the limb, and the elevation or depression at the immediate seat of injury, may be wanting; as in impacted fracture, and in fracture without displacement; and these signs are less pronounced than usual, when one only of two companion bones is broken, the other resisting and supporting as a splint. Shortening also is less marked or absent in all such cases. The most difficult case is this: a fracture of one of two companion bones in the leg or forearm, in a muscular subject, and when considerable swelling has supervened. There is no shortening, and no deformity as from fracture, no crepitation can be felt, and mobility of the broken portions is obscured by the swollen cushion of soft tissues around the seat of fracture. "Where is the surgeon," says Boyer, "who has not hesitated sometimes to deliver an opinion in cases of this description?"

On the other hand, if the signs of Fracture be present, they may, severally, arise from other causes; with one exception,—namely, mobility in the continuity of a bone. This can arise only from fracture. Crepitation attends the play of the tendons in their sheaths, in connection with inflammation; although the creaking, jerking crepitation thus produced, differs from the rough grating of broken bone. The altered contour of the limb, and of the part at the seat of supposed fracture, and the shortening of the limb, might arise from various other conditions; a previous fracture, interstitial absorption, or other disease of the bone, or from deformity, congenital or acquired, as rickets or mollities ossium. In the proximity of a joint, these signs may be due to dislocation; but the presence of crepitation, and of mobility, are the turning points of the diagnosis.

It appears, therefore, that no physical sign taken singly, except one—mobility—is pathognomonic of Fracture, and that any one sign may be absent; but that all these signs taken collectively, determine the diagnosis of this kind of injury. Functional symptoms, singly or combined, are insufficient; yet their concurrence will confirm the diagnosis.

The surest ground of diagnosis is Pathological Anatomy, as directly manifesting during life the existence of morbid conditions; by the physical, the structural, and the chemical changes, which the different textures or organs, and the fluids, affected, have undergone. Thus, in the diagnosis of the general forms of Injury or of Disease:—the *physical* characters of Wounds are distinctive of these injuries, as represented by the terms incised, contused and lacerated, and punctured wounds; the physical signs of Fracture are equally diagnostic, —in the altered length and shape of the limb, and the alteration at

the seat of injury, with the presence of crepitation and mobility at that part; the signs of Dislocation also are characteristic; and the same may be said of most other injuries; while, among diseases, the significance of physical diagnosis is illustrated by that of Tumours; as with regard to their various differences of shape or surface-character, consistence, size, and mobility.

By an appeal to *structural* characters appertaining to the textural elements of Morbid Products of Nutrition,—the cells and fibres, or other organized constituents of such Products, as found in the discharges from natural passages, it may be possible—under examination with the microscope—to determine their nature; whether as to products derived from the mouth, œsophagus, stomach, or intestines, the lungs, kidneys, urinary bladder, or urethra, the uterus, or vagina; or as yielded by the skin, or procured by subcutaneous puncture. This turning out of the interior of the body, or gathering from its surface, supplies the materials for all that minute inspection which is associated with the achievements of microscopic examination. Among tumours or morbid growths, for instance, the diagnostic value of structural characters, and as compared with physical diagnosis, is forcibly illustrated by the differentiation of the recurring varieties of non-malignant tumours, from the typical forms of such tumours. Thus, the fibro-nucleated tumour—a recurring growth, and the ordinary fibrous tumour, possess the same physical characters,—those of a hard, elastic, lobulated tumour; but the recurring form represents only a rudimentary condition of fibrous tissue,—consisting of fine filaments infiltrated with an abundance of well-defined oval nuclei; whereas, the fibrous tumour consists simply of developed fibrous tissue. These two structural conditions can be readily distinguished under the microscope, and by merely puncturing the tumour with a grooved needle, this method of Diagnosis is made available in clinical .examination. Its critical value lies in the fact, that tumours which otherwise present the physical characters of identity, and would thus be mistaken, have yet a widely different vital history and therapeutic importance. An ordinary fibrous tumour, never recurring, admits of removal by the knife as a certain cure; but a fibro-nucleated tumour recurring, is so far allied to a cancerous growth, and when removed, springs up again and again, so that in spite of surgical interference, it not unfrequently runs its course to a fatal termination. The same diagnostic superiority of structural characters, might be further exemplified by the recurring fibroid, as compared with the fibrous tumour, in relation to their vital history and treatment; while something might be said to reclaim the value of the structural method of Diagnosis with regard to cancer-growths.

But, if the microscopic examination of organized products has yielded important diagnostic results in relation to Surgery, how fruitful has been this method of diagnosis in its extension to crystalline forms. No one will dispute the value of the knowledge thus acquired respecting Urinary Deposits. Overlooking the varieties observed in the crystals of each kind of deposit, certain well-defined forms may be regarded as typical, and representing the morbid conditions of urine in which they are found; such crystalline deposits supply conclusive or corroborative evidence of the diseases with which they are more or less constantly and exclusively associated. The rhomboidal prisms of

uric acid; the octohedral and dumb-bell crystals of oxalate of lime; and the prismatic, foliaceous, penniform, or stellate crystals of phosphatic deposits; will severally suffice to identify the morbid conditions of urine, which physical characters, and even chemical tests, perhaps, will not so surely determine. Organized forms occurring in the urine, may supply evidence equally trustworthy; casts of the uriniferous tubules, with blood and pus-corpuscles, presenting their characteristic appearances under the microscope, in connection with acute desquamative nephritis. Or, the artificial production of certain organized forms in urine, after its emission, may be the means of diagnosis; as by the yeast-plant in the urine of diabetes mellitus.

Chemical diagnosis seems to contend with the structural method, for superiority, in regard to its scientific exactitude. Destined, probably, hereafter to become the most minute method of detecting and discriminating the essential changes which constitute morbid conditions, chemical diagnosis has already thrown a vivid and penetrating light on certain classes of diseases which appertain to Surgery. Urinary Pathology, forming a neutral ground for research, has been cultivated by the labours of Prout, Bence Jones, Golding Bird, Lehmann, Julius Vogel, Neubauër, Owen Rees, Lionel Beale, Thudichum, Parkes, W. Roberts, Hassall, and other physicians; but Urinary Deposits have to be examined also by surgeons, if they would practise their art in the light of modern progress. All the various morbid conditions of the urine are of diagnostic importanee in the treatment of surgical diseases, and relative to the favourable circumstances for surgieal operations and their after-treatment. This souree of guidance is often the key to the successes and failures of surgical practice in different hands. Albuminuria is specially significant. The escape of albumen in the urine and the retention of urea in the blood,—the daily loss of so much nutriment in one of its highest forms, and the accompanying ureal blood-poisoning,—constitute a proeess so destructive, that, if overlooked, it would undermine any good results in the whole range of operative surgery. Phosphatic urine, in connection with cystitis, is specially ominous in the treatment of stone in the bladder, as to the relative safety of lithotrity and lithotomy. Now, the chemical tests for these, and all other morbid conditions of the urine, have been reduced to practical forms so simple and conclusive, as to be readily available to every one engaged, and almost under any pressure of time, in Surgical Practice.

Diagnosis may be *confirmed* by the *functional* disturbances, which, as symptoms, aceompany the particular injury or disease; also by conneeting either condition with its *cause* or causes; and by the characteristic effects of the operative or medicinal *treatment* employed. For example, pain, and inability to use a limb, are symptoms in aid of the physical diagnosis of Fracture or Dislocation, although the same symptoms may occur from even a sprain, without either such injury; and the functional disturbances arising from the pressure of a Tumour on surrounding parts are similar, with reference to Tumours of very dissimilar nature. In further aid of diagnosis, the external cause of an injury or disease, may be taken into aceount; the crushing violence to which a limb has been subjected, being presumptive evidence of a comminuted fracture; or the direction in which force has been applied, will perhaps indieate the form of a dislocation. Lastly, the

effects of treatment may confirm our diagnosis; as when, in the reduction of a Dislocation, the sensible snap of coaptation announces the replacement of the articular surfaces; or, the non-recurrence of a Tumour, after extirpation by operation, is evidence in support of its non-malignant nature. Medicinal agents afford, occasionally, diagnostic testimony, by their definite and specific effects; as by the influence of mercury in syphilis, quinine in ague, and sulphur in the cure of itch.

But it is only by careful and repeated clinical observation of the physical, the structural, and perhaps the chemical conditions,—which are the more constant signs of disease or injury; by a similar observation of the functional alterations, as coincident symptoms; the association of causes, and the effects of therapeutic measures; and by connecting *all* this evidence, gathered during life, with the pathologico-anatomical alterations—as demonstrated by the scalpel, the microscope, and perhaps by chemical appliances—after death, and in all stages of these alterations, that we can rationally hope to establish the most *exact* and *earliest* Diagnosis.

This connection, oft-recurring, at length begets self-confidence; so that with the accumulation of such experience, our diagnosis, although determined during life, and therefore by evidence not infallible, yet having been repeatedly verified by *post-mortem* examination, has now become proportionately exact.

The most remarkable result of Diagnosis thus worked out has been the *analysis* of *compound* diseases. Morbid conditions which were formerly regarded as simple, have been discovered to be compound—to consist of several diseases, which may, or may not, be associated; each of which presents its own individual pathological history, and has its own peculiar treatment. One of the most striking illustrations of this diagnostic analysis is afforded by our present differentiation of joint-diseases. The term "white swelling," which was formerly in vogue, is now known to have included at least three diseases of dissimilar character—scrofulous caries, synovitis, and ulceration of the articular cartilages, this analysis having been clearly established by the diagnostic investigations of Sir B. Brodie. Under the old term amaurosis, several distinct diseases of the retina have been discerned. Again, in the province of medicine; continued fever, by the clinical and *post-mortem* investigations of Sir William Jenner, has been resolved into typhus and typhoid; exanthematous diseases as distinct as smallpox and measles. More recently also, the term phthisis pulmonalis, which in the time of Louis signified exclusively tubercular disease of the lungs, is now being resolved into other diseases, by the penetrating analysis of modern diagnostic investigation. It is needless to point out how much all this advancement of Diagnosis has reformed, and is still changing, the old Nomenclature of diseases and the old Nosology or classification of diseases.

2. *Etiology* comprises the knowledge of causes, and their operation, in the production of injury or disease. Such causes may be *external* to the body, as external violence in the production of injury, or exposure to cold in inducing disease; or, they may be *internal*, by the excess, deficiency, or perversion, of structure and function. Both classes of causes may be either *predisposing*, or *immediate* and exciting, in their operation. Sometimes, the former occurs after the latter mode of causation, as when an individual undergoes fatigue or privation, after

exposure to an infectious poison. Then, that weakening of the system cannot be said to predispose, but it is aptly named the *determining* cause.

An innate power of resisting the supervention of morbid conditions, explains why the same cause does not invariably produce its reputed effect in different individuals, or in the same individual, at different periods of life; this uncertainty being due to different degrees of resisting power. But the influence of habitual toleration will also much affect the operation of causes, whether external or internal.

Either kind of cause may be self-sufficient, but both kinds frequently co-operate, or operate in succession; the internal cause more commonly predisposing, the external, when sufficiently aided thereby, immediately inducing disease or injury. Thus, a fall which does not produce a hernial protrusion in one case, immediately does so in another, owing to weakness of the abdominal wall at the seat of rupture, as the structural predisposing condition to this lesion; and a posture which does not cause an apoplectic seizure in one case, immediately does so in another, owing to the blood-vessels of the brain having become brittle from calcareous degeneration.

Causes are also distinguished as *local* and *constitutional*. The former term requires no definition; the latter signifies such conditions of disease as have a systemic character, and a correspondingly wide-spread influence in the production of local manifestations. Such are principally diseases of the blood, of the nervous system, or of nutrition. Local causes may give rise to constitutional diseases; and conversely, any constitutional cause must give rise to, and be manifested by, some local affection or affections. Thus we often speak of the constitutional origin of local disease, a general and most important doctrine of etiology, originally taught by Abernethy.

The detection of internal causes, whether local or constitutional, may be regarded as an extension of diagnosis, and consequently pertains chiefly to Pathological Anatomy; but the operation of these causes, through functional disturbances, comprises the further study of Pathology. Diseases, which were formerly regarded as of local origin, and to be removed by topical applications, have been traced back to their *constitutional* origin in the blood-forming processes; of which such diseases are only manifestations, and are accordingly submitted to constitutional treatment. It has been thus that our knowledge of scrofulous affections has been expanded; that many skin diseases, and ulcerations of mucous membranes, diseases of the eye, the bones and joints, of the testicle, and other parts, have also been referred to constitutional syphilis; while the pathology of gout and rheumatism has been equally fruitful in the interpretation of many otherwise anomalous local affections. Nor has the pathology of the nervous system been unproductive in the same direction; and thus we now recognize hysterical affections of the joints, and other parts of the body, as distinguished from inflammatory disease; a discrimination which has saved many limbs that, doubtless, were formerly sacrificed by an erring surgical interference. On the other hand, the *local* origin of constitutional disease embraces the causative relations of injury, and local disease, to morbid states of the system. In relation to the nervous system, the vital history of injury comprises the phenomena of shock, reaction, prostration with excitement or traumatic delirium, and tetanus.

The doctrine of constitutional irritation, originally established by Travers, was a fertile source of inquiry for subsequent clinical observers; and only recently, the history of shock has been further elucidated by the investigations of Furneaux Jordan and Le Gros Clark; while the phenomena of tetanus, by the original researches of Lockhart Clarke, have been connected with certain definite structural changes in the spinal cord,—a hyperæmic state of the blood-vessels with exudation, and disintegrative softening of the gray substance of the cord. The vital history of local disease, in relation to the nervous and vascular systems combined,—another illustration of the pathological law to which I have referred,—has equally engaged the attention of clinical observers. Thus, we have come to acquire our present knowledge of the pathology of inflammatory fever, as proceeding from a focus of inflammation in whatever part may be effected; and the development, subsequently, of hectic fever from prolonged suppuration, and gangrenous typhoid fever from mortification of the part or local death. All this advancement has been the work of many contributors whose labours cannot be here adverted to.

There is yet another law respecting the operation of internal causes which merits more then a passing notice; it is the *causative relation of local diseases*,—that one morbid condition of a part, may give rise to the same, or to another, morbid condition in another part, continuous, contiguous, or remotely situated in the body. Inflammation exhibits abundant illustrations of these modes of operation as an internal cause. The continuous extension of inflammation is witnessed in its progressive spreading in the skin or mucous membrane, as in erysipelas, and the sore throat of scarlet-fever. Contiguous extension is illustrated by secondary ulceration of the articular cartilages, consequent on caries of the subjacent bone, or on synovitis. So also ostitis may proceed from periostitis; cellulitis from inflammation of the skin; and conversely. Taking internal organs from the head downwards; meningitis is succeeded by cerebritis; scrofulous and purulent ophthalmia, by inflammation of the cornea and deeper textures of the eye; laryngitis, by œdema glottidis; gastritis, enteritis, cystitis, and metritis, each probably, by peritonitis. The transference or metastasis of inflammation to a distant part is exemplified by the supervention of orchitis from the sudden suppression of gonorrhœa. Nervous and muscular affections, of a sympathetic kind, might also be referred to, as a large and most interesting class of manifestations, in all organs and regions of the body, more or less remote from their internal causes; some such affections depending on a cause of irritation in the trunk of the nerve affected, or centrally, in the brain or spinal cord; or, proceeding from the transference of an impression from one distant nerve to another through the medium of the central nervous axis—reflected sympathetic affections. Space will not permit me to enter further into this important view of internal causes. Originally, I believe, investigated by Dr. Whytt, the subject was ably elucidated by Sir B. Brodie in his "Local Nervous Affections," a work which almost more than any other has influenced the practice of Modern Surgery; and yet further light has been thrown thereon, by the researches of Professor Hilton, in his admirable Lectures on "Pain and Rest."

To complete this general view of diseases in their causative relations to each other, I may just notice the association of diseases—their

co-operations and *orders* of *succession* in the body. Constitutional morbid conditions frequently co-exist. This combination of morbid states of the blood and nervous system is exhibited by fever, in every variety. Among blood diseases; erysipelas, which occurs not unfrequently in surgical practice, may co-exist with typhus, or with typhoid fever, with small-pox, or with syphilis—primary or secondary. Local morbid conditions frequently co-exist; as in the association of inflammation with every kind of injury—wounds, burns, fractures, dislocations, etc. As illustrating the order of succession perhaps most commonly met with; a (local) suppurating wound induces (constitutional) blood-poisoning or pyæmia, and this disease is reflected by the formation of (local) secondary abscesses in various parts of the body. Primary syphilis in its relation to the blood, and thence to secondary syphilitic affections, is another familiar example of the same order of succession. Among diseases of the nervous system, we observe tetanus arising from some local injury, and then reacting upon that part, causing it to assume an unhealthy condition. After a strangulated femoral hernia, for which I operated, no bad symptom ensued for a week, then tetanus supervened, and the wound immediately re-opened and became distinctly gangrenous. But I can only glance at the whole of this inquiry, which I have endeavoured to develop in my "Principles of Surgery."

3. *Prognosis* is a department of clinical knowledge, which, compared with modern Diagnosis and Etiology, is far less advanced. To foretell the course and terminations, and the eventual consequences of any given disease or injury, is generally far more difficult than to discover the morbid condition itself, and its causative relations. At the same time, the practical importance of this foreknowledge in relation to Treatment cannot be doubted; whether we look to the prevention of impending complications, of a fatal issue, or of the consequences which may ensue even in the event of recovery. To this end, the old "prognostics" of symptoms being "good" or "bad" according to the suggestions of *empirical* experience, affords no better knowledge than can be acquired by observant nurses no less than by practitioners. On the other hand, the intelligible guidance of Pathology has hitherto failed, in most cases, to cast more than a dim and uncertain light on our prognostications. Why is this? There are two unavoidable difficulties to be overcome. The "natural history" of disease has been watched but little, and recorded less; this deficiency in our knowledge being the result of our having to treat disease, as well as to observe its progress; so that its vital history is continually modified by the intervention of our medicinal agents and operative procedures. Then again, individual peculiarities of constitution, age, sex, social position, and many other circumstances, have to be taken into account, and the influence of which in this or that case, may defy calculation. Certain general principles only seem to be trustworthy: the persistence of causes in their operation, as the immediate ground of Prognosis; with the kind and extent of structural alteration which the organ or part has undergone, and the influence of which is somewhat proportionate to the period during which the disease or injury has continued, unless as a chronic lesion to which the system has become habituated. Beyond this source of foreknowledge, the nature and the importance of the functional disturbances may indicate the probable issue, and its consequences when not a fatal termination.

As the student yet lingers at the bedside over the living human body, to watch all the wondrous phenomena it presents in its multiform diseased conditions,—its innumerable modes of living and modes of dying; and, as he has then revealed to him glimpses of that higher life,—the innermost workings of the soul, as a *moral* agent, when almost dissociated from its co-operation with physical forces; under these privileged circumstances of observation, he will more fully realize the superiority of his *clinical* study of life over that of the pure anatomist and physiologist in their view of the body only through the course of its development and the evenly balanced condition of health; and, in his position of final intercourse with nature, he is favoured with something like an experimental demonstration of that life which is to come, beyond this brief tenure of our earthly existence.

Such, then, are the chief aspects of modern Surgery as a Science. Let me now turn to its practice as an Art. Thus regarded, Surgery, like most other Arts, may be practised in either of two ways—Empirically, by experience alone, or as a Scientific Art, by the guidance of the Science pertaining to it. In its full signification, this Art embraces the scientific, as distinguished from the empirical, practice of diagnosis, etiological investigation, prognosis, and treatment. In its common acceptation, the art of *treatment* is more especially considered; and from this point of view, the aspects of modern Surgery are singularly interesting.

4. *Treatment* derives its Indications from each of the three foregoing heads of inquiry respecting morbid conditions. Diagnosis fixes the essential nature of the morbid condition, and thus not unfrequently indicates the requisite remedial measures, particularly as to surgical operations, manipulative procedures, and mechanical appliances; etiology supplies the knowledge of causes, which, if they be still in operation, must be removed; and prognosis determines the remaining indications of treatment.

A considerable portion of surgical treatment yet remains empirical; but it is now generally felt and acknowledged to be so far aimless, and as often therefore unsuccessful. Such treatment of injury or disease is like trying to hit a mark blindfolded. It can, indeed, only be regarded as a temporary resource, accepted by the practitioner under the pressure of his natural anxiety to relieve human suffering in any possible way, but as often little better than nothing until enlightened by Pathology.

As thus directed, however, Treatment acquires three primary Indications of the highest importance. In proportion as the natural course of any morbid condition is towards an unfavourable issue, the Surgeon thence discovers the *earliest occasion* for interference, and the unfavourable conditions to be removed; while, in proportion as the natural course is towards recovery, it indicates the *least amount* as well as the *kind* of surgical assistance requisite, from time to time, to conduct the case to this happy issue.

Treatment in accordance with the natural course of morbid conditions towards *recovery*, is evidently responsive to the requirements of a *Self-Restorative* or *Reparative Power*, which is inborn and inherent in the living body. The existence of some such power had been recognized by clinical observers from the earliest period, but the practical acknowledgment of its varied operation and resources in the treatment

of diseases and injuries, forms the most prominent aspect of modern Surgery as an Art. A less definite recognition of this power had prevailed from the time of Hippocrates downwards; it was the *archæus* of Van Helmont, the *anima* of Stähl, the *vis medicatrix naturæ* of Cullen; but the original observations of Hunter on Reparation, in the healing of wounds, and after other injuries, first gave this distinctive character to modern surgical treatment. The Restorative Power is manifested, partly in its resistance to external causes of disease, as the influence of cold; but principally, in the processes of nutrition, and other functions whereby structures, when disorganized, are recovered to or towards a healthy state, and readjusted. In relation to the recovery of parts injured, it may be termed the Reparative Power, which is exhibited in all the various processes of reparation, with regard to wounds, fractures, dislocations, and other injuries. Treatment which shall be responsive to the requirements of this twofold power of restoration or reparation, I have long since designated "Conservative," whether in Surgery or Medicine, as denoting its preservative efficacy, the timeliness and moderation of its remedial assistance. (*Med. Times and Gaz.*, 1864-65.)

A few leading illustrations of the power of Reparation, in its various manifestations, as so many laws of Pathology, will inculcate their bearing in the Conservative practice of Surgery. And firstly, the law of Reparation by *Adhesion*, in the Healing of Wounds, and other injuries. The older surgeons, in their treatment of Wounds, never attempted to solicit "union by the first intention," without any intervening blood or lymph; nor did they venture to invite union by "adhesive inflammation," or simply "primary union," through the medium of plastic lymph, as it is now understood. Believing also,—as John Bell records,—that wherever a bone was laid bare, it must exfoliate; until they saw exfoliation take place, they would not permit such a wound to heal. Thus, they would not lay down the skin in a wound over the shin-bone; and if there was a lacerated scalp, they cut the torn piece off. And so too in operations and their after-treatment. If they extirpated a tumour, they cut away also all the surrounding skin. If they trephined the skull, they always scalped the patient; and in amputating a limb, they cut by one stroke down to the bone, or after the flap-operation, they dressed the stump and flap as separate wounds. These references to the past will suffice to illustrate the great change which the Practice of Surgery has undergone by virtue of a distinct recognition of the Reparative power in even one of its almost innumerable modes of manifestation.

Subcutaneous reparation is another law of Pathology, like that of primary adhesion, the recognition of which is due to Hunter; and this law also has conferred an equally conservative character on a scarcely less wide extent of modern Surgical Practice. The wide difference,—both in point of time and *safety*,—between the healing of an injury under the circumstances of exclusion from, or exposure to, the atmospheric influence, has led to the important practical distinction of wounds, as being open or subcutaneous; and the same law lies at the bottom of our distinction of simple and compound fractures and dislocations. Hence it has become the primary principle of treatment with regard to all these lesions and injuries generally, to convert them from the condition of open into that of subcutaneous lesions; whether in the form

of wound, fracture, dislocation, or other injury. The further development of this principle from the subcutaneous reparation of tendons, is exemplified by the practice of tenotomy. Introduced by Stromeyer, in 1831, the subcutaneous division of tendons has become the established treatment of deformities depending on muscular contractions; and in the hands of Scarpa, Dieffenbach, Lonsdale, Little, Tamplin, W. Adams, and other surgeons, tenotomy has created that department of practice known as Orthopædic Surgery.

Enlarging our view of the Reparative power, we observe in the treatment of Aneurism, as now understood, only so many imitations of the modes of natural cure, by the formation of clot and obliteration of the aneurism. As one such imitation, we have the Hunterian application of ligature to a sound portion of artery, at some distance on the cardiac side of the aneurism, just to take off the force of the arterial current, and thus induce coagulation in the sac; a mode of cure which has since been fulfilled also by temporary compression, and for which Surgery is indebted principally to the Dublin school. Distal ligature, or compression, would obtain the same result in the sac, by imitating occlusion of the vessel as occurring from the impaction of a piece of clot, dislodged from the sac into the artery below; and manipulation of the aneurism, as proposed by Sir W. Fergusson, would effect this dislodgment by a manual procedure, which is, however, attended with considerable peril. Then again, galvano-puncture, and injection, are procedures designed to induce coagulation, somewhat as in the event of inflammation affecting the sac—another rare mode of spontaneous cure.

Not to amplify these illustrations of modern surgical treatment, as responsive to the resources of Nature, *medical* treatment also has undergone a similar advancement, at least to the acknowledgment of their curative efficacy. Few surgeons there are who will not, each from his own practical experience, concur in the convictions expressed by an eminent American writer, Dr. Bigelow, in his treatise on "Nature in Disease": "It is difficult to view the operations of Nature divested of the interferences of Art, so much do our habits and partialities incline us to neglect the former, and to exaggerate the importance of the latter. The mass of medical testimony is always on the side of Art. Medical books are prompt to point out the cure of disease. Medical journals are filled with the crude productions of aspirants to the cure of disease. Medical schools find it incumbent on them to teach the cure of disease. The young student goes forth into the world believing that if he does not cure disease, it is his own fault. Yet, when a score or two of years have passed over his head, he will come at length to the conviction that some diseases are controlled by Nature alone. He will often pause at the end of a long and anxious attendance, and ask himself how far the result of the case is different from what it would have been under less officious treatment than that which he has pursued; how many, in the accumulated array of remedies which have supplanted each other in a patient's chamber, have actually been instrumental in doing him any real good? He will also ask himself whether, in the course of his life, he has not had occasion to change his opinion, perhaps more than once, in regard to the management of the disease in question, and whether he does not even now feel the want of additional light?"

The term "Conservative Surgery," as originally understood, when

introduced by Sir W. Fergusson in 1852, was restricted to *operations* for the preservation of some part of the body, which would otherwise have been inconsiderately and unnecessarily sacrificed. The performance of some operation of *removal* having become necessary, in consequence of an incurably diseased or injured state of a part; a lesser and limited operation, the extirpation of that part alone, may then be sufficient, instead of an operation involving also any portion of the sound organism. With regard to two, or more, practicable operations of removal, this consideration of anatomical preservation may guide the Surgeon's choice. For example, excision of an incurably diseased joint may be performed, instead of amputation of the limb. Thus, observes Sir W. Fergusson, "a compromise may be made, whereby the original constitution and frame, as from the Maker's hand, may be kept, as nearly as possible, in its normal state of integrity." This, then, is Preservative Surgery. Surely, however, it may be said, that is simply the object of all true surgery—the preservation of limb and life. Why, therefore, designate it by the superfluous prefix—conservative? "A rose by any other name would smell as sweet;" and Surgery will be equally saving, whether called conservative or not. Yet, on looking back to the gloomy records of the past, to the reckless amputations and mutilations which were then practised, it was not, perhaps, without a significant reason that the true character of Surgery should have been recalled, and a rallying standard erected, for a time at least,—the standard of Conservatism. Is any such admonition still necessary?

Allied to the conservative or preservative character of Modern Surgery, as displayed in operations whereby the *removal* of some portion of the body is effected; another aspect of Surgery has assumed an equal prominence,—its reparative character, as exhibited in the design of the various operative procedures for the *restoration* of parts lost, whether in consequence of injury or disease, or for the construction of parts wanting by congenital malformation. Thence the origin of "Plastic Surgery." Enlightened by physiology in the fact that each individual part of the body has its own separate vitality, and by pathology in the additional fact, that the whole organism is ever ready to re-acknowledge any outlying, or even detached portion, by processes of reparative union; plastic surgery has responded to these overtures of science by the contrivance of some operation of anatomical repair, in almost every region, nay in almost every hole and corner of the body. Thus, rhino-plastic operations have been devised for the repair of structural deficiencies in the nose, these original specimens of surgical reparation being connected with the names of Gasparo Tagliacozzi of Bologna, in the sixteenth century, and Carpue, who introduced the Indian Operation, in 1814; since which period, plastic surgery has visited the lip and palate, in the operation for hare-lip and cleft-palate; while the genito-urinary organs have become the scene of busy reparative procedures for the cure of rectal, urinary, and uterine fistulæ, by closing up these communications between adjoining passages, so as to regain their continuity; and extroversion of the bladder has been met by various constructive procedures. The principle of surgical reparation has lately undergone a remarkable extension, and acquired a new signification. Plastic Surgery had availed itself of portions of integument borrowed, but not detached, from adjoining parts. But the

physiological fact known to John Hunter, that detached portions of the body may be re-united or even transplanted, had been witnessed in such instances as where a bit of the nose or a finger-end, accidentally cut off, was thus restored; and the additional fact of subsequent growth was not unknown; yet the principle involved in these remarkable phenomena remained without much suggestive application in the practice of Surgery. This double law of independent vitality and growth has recently received a most remarkable and fruitful illustration in the practice of *skin-grafting*, as originated by M. Riverdin; particles of skin being implanted on a granulating surface, that each may reproduce integument from itself as a centre, and thus complete the cicatrisation of a large or slow-healing ulcer. Some most remarkable results have been achieved by this method of reparation, the introduction of which into this country is due to Mr. G. D. Pollock, 1870.

Pathology in Surgical Operations.—In the *plan* and *performance* of Surgical Operations, the Guidance of Pathology supplements and completes that of healthy Anatomy.

It is only under the circumstances of disease or injury, and life combined, in one word, Pathology,—as supcradded to Anatomy, that the operating surgeon interferes. He is never called upon to touch the body in its healthy and dead anatomical conditions. Surgical Anatomy, properly so called, is found to be modified throughout by constant association with pathological conditions, in the performance of any operation. Such an association therefore will tend to correct the *purely* Anatomical impressions of the Student, and to safely guide the operating Surgeon. Certain Operations are only apparent exceptions to this otherwise unexceptional law in Operative Surgery. It may be that the seats of operation and of disease or injury are not identical; that our operation is somewhat removed from the diseased or injured locality. Such are amputations, and the ligature of arteries for aneurism. But even under these circumstances, pathological anatomy can alone determine whether or not we operate clear of the disease and amid healthy tissues; whether, for example, the bone and soft parts left after amputation are healthy, and whether we cast our ligature around a healthy portion of artery. This *negative* application of pathological anatomy is obviously of the highest importance in respect to the successful results of surgical operations.

On all other occasions, the physical properties and relations of parts disclosed during an operation are then so changed by disease as sometimes scarcely to admit of recognition; and thus it is that anatomy *plus* certain pathological alterations, or the *pathologico*-anatomical conditions of the body, are those with which the operating surgeon is concerned.

Guided by this *à priori* principle, we can predicate those pathological conditions which from their nature must chiefly influence the performance of surgical operations; alterations of certain physical properties, more especially of colour, consistence, and elasticity; also modifications of shape and size, with those affecting the situation, position, and relation of parts. Such peculiarities altogether change the scene with which the mere anatomist is familiar.

Nor are these the only circumstances that overshadow the appearances to which he is accustomed. Whoever has observed the arm of a dead subject as it lay extended over the side of a dissecting-table, must

have been struck with the well-marked bicipital depression, especially visible on a thin subject. If injected, the brachial artery can almost be distinguished as a prominent line throughout its course. Apparently, a single incision would bring one down upon the vessel, and so it does. The skin, gluey and adhesive, hangs upon the knife; nor does the incision gape; the artery is soon exposed, not being overlaid by the contracted biceps, and only, perhaps, obscured by the turgid vein on its inner side. Contrast all this with the same proceeding during *life*. We observe no such well-defined groove to guide our incision; the skin yields before the knife with a crimp and elastic resistance; the wound gapes; the swollen and vibratile belly of the biceps muscle, especially if amply developed, overlays the artery, while the vein, perhaps not so turgid, immediately conceals it. More or less hæmorrhage will also further obscure the vessel, which can only be recognized by its beautiful fawn colour and its pulsating under the finger. I have purposely excluded the brachial plexus of nerves from this sketch, in order more clearly to contrast the *dead* with the *living*.

This illustration will apply, *mutatis mutandis*, to operations for the ligature of other arteries; and the experience of every practical Surgeon will supply him with the more extended application of the same principle to all other surgical operations.

We must, therefore, acknowledge also the guidance of *living* conditions in the performance of surgical operations. The condition of life modifies certain physical appearances, and chiefly those affected by *pathological* anatomy. Thus, the colour, consistence, elasticity, and even the size and shape of the various parts of the body, their situation, position, and relation to contiguous parts, are presented to the Surgeon, when modified by the twofold conditions of *Disease* and *Life* combined.

Pathology,—conjoined with Anatomy,—is, therefore, our guide during surgical operations. In proportion as we are familiar with pathological conditions, by so much are we enabled to foresee, and to provide for, the peculiar appearances and conditions which the knife discloses, and to recognize them as they are successively presented in surgical operations.

Guided by this anticipatory knowledge, our operations are no longer discoveries made by dissection, but *planned* and *methodical* proceedings, conducted on known principles; in fact, an Art, based on the science of Anatomy supplemented by Pathology.

The twofold Principle I have advanced will be further elucidated by tracing the *combined* influence of disease and life on the scenes of the chief Operations of Surgery. And here the results of *inflammation*, meeting us so constantly, first invite attention. The swelling that accompanies an effusion of serum, or pus, in the event of suppuration, deepens and displaces those tissues amid which it infiltrates. Their physical properties are soon changed. Cellular tissue, so abundant, assumes the appearance of wet tow; muscle becomes soddened and discoloured; the larger blood-vessels perhaps alone escape, appearing dissected out and isolated from their adjoining tissues. Or, the fibrin effused solidifies, and its more or less complete organization ensues. If the latter change, then induration and subsequent contraction of the tissues affected, together present pathological conditions which contrast with those arising from the mechanical agency of fluid. If

gangrene supervene, then we observe the gradual loss of all the physical properties peculiar to each living tissue, as severally they are consigned to the uncontrolled dominion of chemical forces. Observe the skin darkened or black, and also the intermediate tints of tissues between it and bone, whitened and rough. Moreover, the tissues resign their consistence and elasticity as they imperceptibly lose their organization and return to a liquid form. I would not locate these changes, because with unimportant differences they may occur in every region with which the operative surgeon is concerned.

If we review the history of other products not due to inflammation, we observe them disturbing the relation of parts surrounding their locality, and by pressure gradually obstructing and even obliterating hollow organs in their vicinity. The clinical history of all tumours or swellings exemplifies these mechanical results; but *growths* more especially, by their gradual and unlimited enlargement, produce such displacements. This circumstance chiefly determines the necessity for extirpating tumours which are otherwise harmless in their local and constitutional consequences. I would not allow such benign growths, as fatty or fibrous tumours, to remain too long imbedded; for, although the general health may continue uninfluenced thereby, they may yet by their gradual enlargement so far encroach on adjacent and important parts as eventually to render their own removal difficult, if not impracticable. This indication more especially refers to tumours situated in regions where vital structures are crowded together. Such are the face and neck, where the presence of large vessels, nerves, etc., complicates the removal of tumours. Under these circumstances I have removed more than one tumour, which, although of innocent tendency, would soon have passed beyond the ramus of the jaw posteriorly, and had already encroached on the cavity of the mouth. This condition would suggest the early extirpation of tumours, benign in themselves, when lodged in the sides of other cavities; as, for example, the abdomen and joints. Thus placed, they might by pressure and inward progress eventually endanger life, if their removal were attempted at a later period.

Next, inspect certain *regions* of the body, in which the relation of their pathology to surgical operations being more special is even more conspicuous.

Observe *aneurisms*,—say one of the axillary artery. The mere anatomist would suppose that the subclavian artery in the outer third of its course would offer no special obstacles to its easy deligation. On the dead subject but few exist. The operator observes the depression over the vessel, in the situation supposed, above the clavicle. He makes his incision along that bone; he very soon recognizes the subclavian vein below, branches of the brachial plexus above; and the shoulder being now depressed, he at once passes a ligature around the artery. But with the shoulder *elevated* by an axillary aneurism, and the artery above having a corresponding depth, the vein turgid from obstructed return of blood, and more so under chloroform, the sterno-mastoid and omo-hyoid muscles swollen, with perhaps also a portion of the trapezius; these modifying conditions of disease and life combined, all conspire to render this operation perhaps the most difficult in surgery. They tried the skill of a Liston and a Dupuytren; the former of whom at

first ligatured the lower cord of the plexus instead of the artery; the latter, at the end of one hour and forty-eight minutes, only succeeded in casting a ligature around the fourth cervical nerve! Need I say more for the influence of aneurisms on adjacent parts during life?

Turning to *hernial tumours*, as I would term them for my present purpose, how significant is the relation of Pathology to Operative Surgery! The mere anatomical knowledge of the so-called "coverings" of herniæ will avail but little when tested by an operation on the living body. I can understand the coverings of a piece of intestine when thrust in the direction of a hernia through the crural or inguinal apertures in the dead subject. We might then dissect and display the superimposed layers of tissue thus artificially made tense. We might successively remove the skin, superficial fascia, intercolumnar and cremasteric fibres, with perhaps also some cellular tissue and the fascia transversalis from off the sac of peritoneum, successively covering a portion of intestine thus protruded through the internal inguinal aperture. But I cannot understand how all this applies to a recent oblique inguinal *hernia*, and still less to one of former date; for then the external and internal inguinal apertures are found so approximated, and the "coverings" enumerated so matted together by constant pressure, as to have altogether effaced their mere anatomical characters and relations. In like manner, what are the "coverings" of femoral *hernia?* One stroke of the knife might bring us down upon the sac, through skin and fasciæ—superficial, cribriform, and transversalis; where is the septum crurale? It therefore appears that Anatomy can be used only as a *diagram* for the study of herniæ, and that, like other pathological conditions, we must rely on the knowledge of herniæ themselves to direct us during operations for their cure. In short, we can no longer put our trust in Anatomy *alone*, but may rely with confidence on Pathology as our guide.

Looking around the *urinary bladder* and *neighbouring organs*, we again discover the intimate relations of Pathology to surgical operations.

The thin scrotal skin and tunica vaginalis may easily be transfixed with a common needle, and one might therefore suppose that the fluid of a distended *hydrocele* would always be readily detected and evacuated. Apart from pathological experience, no one could have predicated from mere anatomical knowledge that the tunica vaginalis may itself become so thick and dense as not only to disguise the fluctuation and translucency of hydrocele, but to yield before the point of a trocar with the resistance of thick pasteboard.

Should the *testicle* require removal, how much are our incisions modified and the adjacent parts endangered by the enormous bulk to which this organ and its coverings sometimes attain? The urethra and fellow testis might be wounded by a bare turn of the knife. Anatomy *per se* can only funish our landmarks under these circumstances, and we must trust to our actual experience of such tumours and in their removal from the living body.

Again, the every-day operation of *catheterism* cannot be learnt on the dead subject. The parts are then so peculiarly flabby, and the *urethral passage* so adhesive to even a well-oiled catheter, as to communicate no sensation of that grasp of the instrument which an operator experiences during life. If, indeed, the urethra be indurated and

contracted with *stricture*, then certainly we can learn nothing but the direction of the passage by practising on the dead body. In passing an instrument, the Surgeon's hand should be tempered by the vital conditions of the urethral canal,—its muscular irritability, its nervous sensitiveness, and perchance its disposition to bleed; coupled with the various states of organic induration and contraction met with at the seat of stricture.

Should *retention of urine* demand relief, additional *pathological* knowledge may be needed. The variable size, shape, and consistence of the *prostate*, and even its relative position to the neck of the bladder, as altered by disease and examined during life, will further determine our pathway,—per urethram, or per rectum,—when guided no longer by pure anatomy and lost to sight.

Approaching the *bladder*, and inspecting the scene of other operations designed to gain an entrance thereto, we find, wherever we seek admission, that our procedures should be governed by anatomy, modified by the twofold conditions of disease and life combined. Is it our intention to remove a calculus by the *lateral* or Cheselden operation? Then what availeth it us to know that our incision through the skin may also divide the superficial perineal branches of artery and nerve, and will inevitably sever the inferior hæmorrhoidal? No anatomical knowledge, however exact, could foretell how far distant the artery of the bulb may be from the margin of the triangular ligament which is not seen; nor can we discern the transverse artery and muscle, and still less perceptible are a few fibres of the levator ani. Yet such are some of the misleading details of Anatomico-Surgical works respecting "the parts cut in lithotomy," or "the structures divided in this operation." All we know, or care to know, is, that as our first or perineal incision was directed by anatomical considerations, so also that a trifling stroke or two with the knife is continued until, guided upwards by the point of our left forefinger, it enters the groove of the staff just in front of the prostate gland; the knife being then carried onwards through this body into the bladder, is followed by the finger; which, at once a protector of the rectum, a blunt gorget, and searcher, is required to discover the pathological conditions of the prostate and bladder, as it dilates the former and explores the latter, for the situation of the stone, just before sliding the closed blades of the forceps over the finger, as the guide thereto.

The foregoing illustrations afford sufficient evidence of what Pathology can do for the performance of Surgical Operations.

Without the knowledge of Anatomy, attired in the garb of disease and life, neither safety nor success can be attained in the planning and performance of Surgical operations. "The operator,—I would say, without *this* knowledge,—is seen agitated, miserable, trembling, hesitating in the midst of difficulties, turning round to his friends for that support which should come from within, feeling in the wound for things which he does not understand; holding consultations amid the cries of the patient (before the days of chloroform), or even retiring to consult about his case, while he lies bleeding, in great pain and awful expectation." But the old carpenter style of Operative Surgery, derived merely from the dissecting-room, is passing away; it belonged to a period when Surgery ranked with the mechanical arts, and shared their honours.

No less important in Operative Surgery is the knowledge, partly Pathological, to which I would next direct attention, as mainly determining the *success* of operations.

Conditions Favourable and Unfavourable for Operation.—The selection of cases fitted for Operation should always most seriously engage the Surgeon's consideration.

The Conditions Unfavourable for any Surgical procedure being known, all other conditions may be presumed to be favourable.

Unfavourable conditions comprise: (1) certain states of the Patient's Health, constitutional, and local in regard to the seat of disease or injury,—in short, certain Pathological conditions; (2) the Hygienic circumstances by which he is surrounded.

Constitutional conditions unfavourable for Operation, relate both to the mind and body.

Persons who are naturally of an irritable and anxious, or of a desponding, *mind*, cannot sustain a surgical operation so well as those of a tranquil and cheerful disposition. This rule holds good also in the case of persons who, from temporary circumstances, may be mentally affected in like manner. And especially unfavourable, is any despondency respecting the issue of the operation itself. This adverse influence affecting the patient's bodily health, before and after the operation, will be alone sufficient to undermine the result of any skill on the part of the Surgeon. On the other hand, the sustaining influence of hope is well exhibited by the fatal effect produced when it is suddenly withdrawn. Sir A. Cooper tells the story in his Lectures of a poor countryman in Guy's Hospital, who, lying in bed previous to a capital operation, was asked by a student what part of the country he came from; "Cornwall," he replied. Then said his interrogator, "You will never see Cornwall again." Nor did he; the man never rallied.

An instance of such heartless or thoughtless indiscretion, suggests the kind of address and tact, animated by honest sympathy, with which the true Surgeon will manage his patient's mental disposition, ever fairly supporting hope as the well-spring of life.

Conditions of *bodily* health, of a constitutional character, unfavourable for Operation, are numerous. They relate to all the organs of the body, and vary in importance according to the physiological agency of the organs in maintaining life. Thus, the nervous system, the heart, lungs, disgestive organs, and excretory organs, especially the kidneys and skin, have severally to be considered, and from a twofold point of view. Firstly, organic conditions must be considered, as affecting the general health, and thence the life, of the individual, when subjected to any particular surgical operation; and, secondly, they should be regarded in relation to reparation, or the reserve-power of nutrition requisite after any operation of magnitude, and which necessarily also entails an ordeal of some duration for the system to undergo, before the health can possibly be re-established.

Age, or *Period of life*, has a very significant relation to the probability of recovery after surgical operation, no less than from any injury of equal severity. Extreme periods of life,—*infancy* or childhood and *old age*, are about alike unfavourable for operation, as affecting the nervous system—by shock, and the circulation—by hemorrhage. But old age, or an approach thereto, is more especially adverse, owing to the degenerations of textural structure which the vital organs have

naturally undergone in the course of this period of life. Nutrition is inactive, and reparation accordingly is defective; hence the special liability to secondary hemorrhage—the vessels being insecurely closed, and to pyæmic infection—the wound remaining open; or exhaustion ensues from the prolonged process of repair, and thus the patient is apt to sink even during convalescence.

Bad subjects for surgical operation are those persons who, if not old in years, are yet, in appearance, old—prematurely—for their age. Certain types of this description are vividly portrayed by Sir James Paget in his highly suggestive "Clinical Lectures and Essays": "They that are fat and bloated, pale, with soft textures, flabby, torpid, wheezy, incapable of exercise, looking older than their years, are very bad. They that are fat, florid, and plethoric, firm-skinned, and with good muscular power, clear-headed, and willing to work like younger men, are not indeed good subjects for operation, yet they are scarcely bad. The old people that are thin, and dry, and tough, clear-voiced and bright-eyed, with good stomachs and strong wills, muscular and active, are not bad; they bear all but the largest operations very well. But very bad are they who, looking somewhat like these, are feeble, and soft-skinned, with little pulses, bad appetites, and weak digestive power; so that they cannot, in an emergency, be well nourished."

Previous habits of life are connected with some such bad subjects for surgical operation. *Habitual intemperance*, in the use of stimulants, is specially unfavourable; whether the individual be a confirmed drunkard, or an habitual soaker, who never appears to get drunk. The latter are, indeed, worse subjects for operation than the former. On the other hand, *teetotalers*, as being more often reclaimed drunkards, are also by no means good subjects. "Of such people," observes Sir James Paget, "I have no good opinion when they come to be the subjects of surgery; for they seem to retain the bad liabilities of the intemperate long after they have given up their bad habits." Habitual *over-eating*—another mode of intemperance—is scarcely less important, although perhaps less generally prevalent, relative to the risks of life from surgical operation. Among the "upper classes," not a few persons are thus bad subjects,—having their blood surcharged with unassimilated food, especially of an azotised character; and this evil condition reaches its maximum in the retention of excrementitious matter, from the want of bodily exercise, or when relieved only by "carriage-airings." I proceed to notice, more particularly, various constitutional and organic conditions.

The state of the *nervous system* is a primary consideration. When itself naturally irritable, or when in an irritable state for the time being, this condition is peculiarly unfavourable for surgical operation. It seems to be associated with a weak circulation, and the patient is apt to sink soon after any severe surgical procedure. But the judicious administration of opium with wine, brandy, or other stimulants, will often succeed in preparing the patient for operation, and carry him or her through the critical period subsequently. Chloroform, besides preventing pain, has a specially beneficial influence in irritable nervous persons, subjected to operation for surgical disease, or when the circulation is depressed by the shock of injury. Hysteria does not render the patient liable to any special risk; the sensibility to pain not being attended with any notable excitement of the circulation or

fever, and the power of repair is unaffected by the constitutional peculiarity.

Certain *blood diseases* prohibit any operation, otherwise than one of immediate necessity for the preservation of life; as hernia or tracheotomy. Thus, any operation of choice should be postponed when the patient is labouring under erysipelas or pyæmia. Other diseases have not a fatal tendency, yet their existence is adverse to the successful result of an operation. Such are scrofula, and the contamination of the system by malignant disease. In the latter case, an operation will be almost surely followed by a return of the disease, *in situ*, or its development in some distant part.

Heart disease, and particularly fatty degeneration of this organ, should make the Surgeon consider the necessity or the advantage of any operation attended with much loss of blood or shock to the nervous system. Consequently, when the pulse is habitually feeble, irregular, and perhaps slow, the patient breathless on slight exertion, and marked with the arcus senilis; these symptoms co-existing, almost surely indicate fatty degeneration of the heart, and should warn the Surgeon that he has a bad subject to deal with.

Lung disease does not seem to have so important a relation to Surgical Operations. This may, perhaps, be explained by the fact that after any severe operation, the patient being confined to bed, there is no special demand on the function of the lungs as the organs of respiration. As double organs also, one may be more or less diseased and incapacitated, and the other fulfil a double or compensatory function, and especially in the case of old-standing disease. Phthisis is an exceptionally unfavourable condition, and particularly if this disease be in an active state or in an advanced stage. The operation for fistula in ano, a disease often co-existing, should not be performed under these circumstances.

The *Digestive Organs* play a most important part with regard to the *result* of surgical operations, and disorders or derangements of these organs demand the most careful consideration. Obviously this is due to the necessity arising after any operation of magnitude, for an extra supply of nutritive material to meet the demands of the reparative process, a supply which implies an active state of the digestive organs incompatible with any kind of indigestion. Irritable dyspepsia, and hepatic derangement, terms not very definite, but sufficiently familiar in practice, represent the conditions which are most adverse to surgical procedures.

The *Kidneys* and *Skin*, as excretory organs, have a grand relation to surgical operations by purifying the blood of noxious matter, the retention of which would inevitably spoil the material requisite for reparation. Disease of the kidneys, in the various forms of degeneration, accompanied with albuminous urine, and the retention of urea in the blood, constitutes the most unpropitious condition under which a patient can be subjected to operation. The wound is apt to undergo diffuse inflammation and sloughing, while the patient sinks rapidly from the exhaustion of blood-poisoning. This seems to arise from the local products of inflammation, thus induced, becoming absorbed, and which accumulating in the blood, soon overwhelm the system beyond the endurance of life, when already oppressed by the uræmic poisoning. In this condition also, both kidneys are diseased, so that there is no

chance of any relief by one organ compensating for the functional deficiency of the other, as in the case, sometimes, of the lungs.

The state of the skin must also be taken into consideration before undertaking any operation. A cool, moist, soft, perspiring skin is no less conducive to success, than a free secretion of healthy urine. Chronic diseases of the skin, such as lepra or psoriasis, involving a large extent of the cutaneous surface, had better be treated before proceeding to any surgical operation which can be postponed.

Pregnancy does not prohibit any surgical operation, excepting in so far as this state may thereby be itself affected. In the case of a lady advanced in pregnancy, I have removed a large slough from the abdominal wall by incision, without disturbing the course of pregancy; but, on another occasion, in the same person, the removal of necrosed bone from the scapula, under the influence of chloroform, was followed by a miscarriage the next day.

Idiosyncrasy, or some unknown constitutional condition peculiar to the individual, may prove singularly prejudicial to the success of even a trifling operation. Thus, in one case, after removing a small fatty tumour from the abdominal wall, on the following day the adjoining integument presented a sphacelated black patch, with an abundant, thin suppurative discharge from between the lips of the incision.

Local conditions unfavourable for operation relate to any diseased state of the part itself, which will tend to produce an unsuccessful result. Thus, acute inflammation of a joint, for example, would be adverse to excision; and a sloughing condition of the parts involved in the flaps of an amputation, would defeat the purpose of this operation. Cancer, or disease of a malignant nature, should never be removed, unless the whole disease can be freely extirpated. Any portion beyond the reach of operation will necessarily cause a return of the disease, *in situ;* an important consideration, in addition to the question of probability as to the development of cancer in some distant part.

Hygienic Conditions.—Besides the state of health, constitutional and local, by which a patient may be in an unfavourable condition for operation; the hygienic circumstances in which he is placed, both before and afterwards, will much affect the probability of success. Adverse hygienic conditions comprise chiefly: Defective Diet, in quality, quantity, or in both respects; Overcrowding of the sick and wounded, especially those having open and suppurating wounds, or Deficient Ventilation, associated with which is the Exclusion of Sunlight; Defective Drainage; Exposure to Contagious or Infectious matter, by dressings or inhalation, as in the propagation of Hospital gangrene and erysipelas. Some of these adverse circumstances, relative to operation, require further consideration, beyond what ordinary experience would suggest.

Deficient Ventilation.—The *minimum space* allotted to patients in the Surgical Wards of an Hospital should be 1500 cubic feet of air to each person. And this quantity must be accompanied with change of air also, by proper ventilation. In different Hospitals, the number of cubic feet of air per bed varies considerably. Civil Hospitals range the highest; in England, the wards of Hospitals with relation to the number of beds, are calculated to allow an amount of space varying from 600 to 2000 cubic feet per bed, and in London the allotment is increased even to 2500 cubic feet; in the Hospitals of Paris it is less—

1700 cubic feet. Military Hospitals, in general, have not been arranged on the same liberal seale; 800, 700, or even 300 cubie feet of air for eaeh patient having been deemed suffieient, the army regulations thus being a provision for overcrowding. But, more reeently, this hygienic defeet has been reformed. Thus, in the Herbert Hospital at Woolwich, the allotment of spaee per bed is 1200 or 1400 eubic feet. A surgieal ward for twenty patients should measure 80 feet long by 25 feet wide, and 16 feet in height; thus allowing about 1600 eubic feet per bed. Eaeh bed or patient should have a surfaee area not less than 8 feet wide and 12 feet long; eubie space over the bed would be an insufficient provision. Consequently, the arrangement of beds should allow at least three feet between eaeh on either side, and 12 feet between foot and foot. In the event of infeetious disease, further isolation of each patient will be advisable, and either or both adjoining beds should be left unoeeupied. Atmospherie impurity, whether proceeding from the person or the exeretions, diminishes as the square of the distanee. In open localities, or in the eountry, less than the average eubic spaee per patient is requisite than in towns and erowded districts. Hence, the advantage of an Hospital built in detaehed seetions, as New St. Thomas's, and of Cottage Hospitals; also the greater eomparative salubrity of huts or tents in the Military Hospital system,—an advantage which I experienced with regard to patients in the wooden huts on the heights of Balaklava above the sea, and whieh was also strikingly exhibited in the Franeo-Prussian War. In private praetiee, the aerial conditions of our London squares are more favourable than in narrow old streets; while in poor districts, the dense neighbourhood, small and ill-ventilated rooms, overcrowded and badly drained tenements, represent the eonsummation of unfavourable atmospherie eonditions.

Sunlight has a decidedly benefieial influenee, whieh should not be overlooked, in relation to the general health, and thenee to recovery after surgieal operations; exeepting when the supervention of inflammatory fever would indicate the propriety of exeluding any source of disquietude, or, again, after ophthalmie operations, where the stimulating action of light would be direetly injurious to the eye. The sanitary influenee of solar light is referable not only to the light and heat, but also to the ehemical rays whieh are known to be assoeiated; and this eompound emanation has a potent action on all vitality. In the vegetable kingdom, the blanehed appearanee of plants reared in dark loealities, eontrasts sadly with the brilliant tints of flowering plants grown under sunshine; and among animals, similar peeuliarities with regard to eolour are observable in different localities or elimates, from the white polar bear of northern latitudes, to the gay plumage of birds in tropieal eountries. In the human species, colour is developed by solar light, as shown by the inhabitants of different elimes, and by the influenee of eaeh returning summer; but the pallid appearance of the artizan in dark workshops, or of offiee-clerks, compared with the ruddy brown hue of the countryman, presents not only a striking eontrast of apparent health,—the anæmie and enfeebled state of the one is no less unfavourable for surgieal operations. This anæmie eondition is due, partly at least, to the habitual absenee of sunlight in certain oeeupations. The production of pigmentary matter, whether in the cuticle, or as the eolouring matter, hæmatin, of the red eorpuscles of

the blood, is affected by solar light. Hence the importance of ample sun-lighting, by the arrangement of windows in the wards of Hospitals, or in the bedrooms of private patients, especially with regard to recovery after the loss of blood incident to many surgical operations.

Defective Drainage, in its causative relation to the generation of typhoid fever, is now generally acknowledged, and the noxious influence of decomposing animal or vegetable sewage-matter, in surgical practice, is too well known to need further notice.

Exposure to Contagious or Infectious Matter.—Among the characters of Modern Surgery, as an Art, Preventive treatment has acquired a position of great importance. The human body is encompassed by many external causes of disease, which may be not only of a palpable kind, but exist as subtle influences, wafted about in the air or impregnating the water, by either of which media they may find an entrance through any breach of the cutaneous surface, and must gain admission in the act of breathing or the reception of food. Other such agents there are in the recognized form of virus, ever ready to be communicated from one affected human being to another, or from the bodies of animals through poisoned wounds. Here, then, are so many sources of contagion or infection; the latter term sometimes being restricted to the reception of the morbid influence through the medium of the atmosphere, or by means of any other intermediate substance, called fomites. Certain diseases of contagious or infectious character more especially pertain to Surgery; principally erysipelas, pyæmia, and Hospital gangrene. Yet these diseases are preventible, chiefly by cleanliness in dressings, and clean or fresh air, the latter requirement having reference to free ventilation, and isolation of the patient or patients affected. *Antisepticism* may be regarded as disinfection in the treatment of wounds, not primarily poisoned; the object being to prevent the putrefaction of any animal fluid, as blood, liquor sanguinis, or pus, in contact with an open wound, and the consequent systemic infection known as pyæmia or septicæmia; the one disease signifying, literally, purulent infection of the blood, the other, that infection which arises from the introduction into the blood of decomposing animal matter, septic matter, of any kind. Hence the so-named antiseptic dressings, in all their variety; for the experimental investigation of which, with regard to carbolic acid in particular, Surgery is principally indebted to Professor Lister, of Edinburgh. Diseases which arise from the local introduction or inoculation of any virus, as in Syphilis, are also far more of a preventible nature than amenable to any known curative treatment.

Preparation of Patient for Operation.—It is scarcely necessary to observe that, on the ground of personal liberty of the subject, and legal liability of the Surgeon, the consent of the patient, and of his or her immediate relatives, should first be obtained before proceeding to any surgical operation. But this rule will as necessarily admit of exceptions, according to the mental capacity, or the age of the patient, and the more or less urgent nature of the case proposed for operation.

If the patient be sensible, of sound mind, and mature age; and he resolutely and persistently refuse to allow an operation of urgency to be performed; and if, moreover, his determination be backed by that of an immediate relative, as his wife; the Surgeon will have no alternative but to give up the responsibility of the case. Thus, I have

seen a man die from strangulated hernia, in spite of my earnest and repeated remonstrances to him, and to his wife, as the strangulation proceeded to a fatal termination. On the other hand, if the patient be insensible, or imbecile, or in the case of a child or infant, and in the absence of immediate relatives or parents, the operation being an urgent one, the Surgeon will be free to act according to his own judgment.

The preparation of the patient, mentally and bodily, will consist in inspiring him with cheerful hope, and in bringing his bodily health to a quiescent condition, especially observing that the actions of the digestive organs, and of the skin and kidneys, are healthy, when time can be allowed for any such preparation. This tranquil, even state of mind and body, is that best fitted for operation. But, when no time can be permitted for any constitutional preparation, as after most severe injuries, the patient must be at once submitted to operation.

Arrangements for Operation.—The arrangements requisite for the efficient and convenient performance of surgical operations, relate to the Room, the Operating-table, Instruments, with other Appliances, and Assistants.

The *Room*, of convenient size, should admit a good light, an over-head or sky light being very desirable for most operations; it must be adequately warmed in cold weather, or for the performance of operations wherein the abdomen is opened and the viscera exposed, as in operating for strangulated hernia and in ovariotomy; but there should also be the means of free ventilation or change of air about the patient, when under the influence of ether or chloroform. Besides the requisites of light, temperature, and air, an ample supply of water, warm and cold, must be at hand.

The *Operating-table* must be strong, and firm-standing (not moving on castors), of convenient height, and width only of the body, covered with blankets overlaid with india-rubber sheeting, and provided with pillows. The tables constructed for operation, as used in Hospitals, are fitted with a mechanism for raising the head and shoulders to any requisite height; and flaps are provided for leaving the legs unsupported, as for amputation, or when the nates are placed so as to rest over the end of the table, as for lithotomy, and other perineal operations. A low, firm stool will be a requisite accompaniment for these operations, to seat the operator in cutting for stone, or an assistant in holding the leg for amputation. An Operating-chair, instead of a table, is necessary for cases wherein the patient is seated; as in operations about the face, the extraction of nasal polypi, for cleft-palate, or the removal of either jaw; also for other operations, as amputation at the shoulder-joint, and tapping the abdomen. The chair itself, firm-standing, and high-backed to support the head, much resembles a dentist's chair. These arrangements respecting the room and table should be seen to by the Surgeon himself, when not regularly provided as in a Hospital; but the remaining provisions, as to instruments and assistants, must always be personally superintended.

The *Instruments* necessary should be well selected with regard to the nature and possible complications of the operation; and for convenience, they should be arranged on a small table or tray, in the order in which they are to be used, and placed near the Surgeon, so that he can help himself to any instrument he may require, or have it

handed to him immediately by an instrument-assistant. The collection of instruments, however few, had better be covered with a towel, to conceal them from the eye of the patient when brought into the room. Sponges, of various sizes, clean and compressible, with lint and plaster, will always be provided by any well-trained nurse; but here again, the Surgeon had better see that these appliances are at hand. Any splint or other accessory requisite for application after operation, and previously prepared by the nurse or an assistant, should also be inspected. A tray containing sawdust or sand may be placed on the floor so as to catch the blood; but this has a repulsive appearance, and it is more agreeably substituted by a piece of maroon-coloured oil-cloth under the table. The operator may be conveniently dressed, in an easy-fitting, long-cut alpaca coat, or dressing-gown.

The *Assistants* should be in number sufficient, but not superfluous, and each should have an allotted duty to perform, orderly and silently. Thus, for a capital operation, as amputation, joint-excision, or lithotomy, four, or not less than three assistants, will be required; one, specially to administer chloroform; then, in the first-named operation, another to command the main artery; a third to hold the limb in position; and a fourth to take charge of the flaps, and ligature the vessels as they are seized by the Surgeon. A fifth assistant might hand the instruments; but they are often taken up most readily by the Surgeon from the table near to him.

Anæsthetics.—The greatest gift of God to man, through Natural Science, is, perhaps, the discovery of means for the prevention or the abolition of bodily pain. This exemption approaches the realization of that blissful hereafter, one of the Divine promises of which is, that then "there shall be no more pain."

Glimpses of the truth as now made known had appeared in various ages; but it was not until the year 1800 that Sir Humphry Davy, having himself experienced relief from pain while breathing nitrous oxide gas, suggested the possibility of employing the influence of this agent for the same purpose in surgical practice. After the lapse of nearly half a century, in 1844, the same idea occurred to Dr. Horace Wells, a dentist in Hartford, America, who underwent the extraction of a tooth without pain after inhaling the gas, and he administered it with the same effect to several of his patients; but, finding the practice uncertain, he soon abandoned it. About the same time, Dr. W. T. G. Morton of Boston, in America, who had previously been a partner with Wells, sought of his own accord, without it would appear receiving any suggestion from him, to discover an efficient anæsthetic; and having experimented upon himself and the lower animals, he extracted a tooth painlessly from a patient, under the influence of sulphuric ether by inhalation; this event taking place on the 30th of September, 1846. He then publicly exhibited the efficacy of this agent at the Massachusetts General Hospital; and thenceforward anæsthesia in surgery became an established blessing to mankind.

It was not long ere this invaluable discovery was recognized, and followed up by farther investigation in this country; which resulted in the introduction of *chloroform*, and its employment instead of sulphuric ether. The latter agent is still extensively used as an anæsthetic in America; but in Europe, chloroform is generally preferred to it, or was so, at least, until quite recently. Disguised under the name

"chloric ether," in which it exists diluted with spirit of wine, this agent was employed by Dr. Morton in his first experiment upon himself; and it is a fact, not perhaps generally known, that it was also used in the same form, in preference to sulphuric ether, by Mr. Lawrence, at St. Bartholomew's Hospital, in the summer of 1847.

It was in the autumn of 1847 that Dr. Simpson, who was engaged in a series of experiments with various narcotic vapours, employed for the first time the active principle of chloric ether, at the suggestion of Mr. Waldie, of the Apothecaries' Hall of Liverpool; and finding that pure chloroform had certain advantages over sulphuric ether, he zealously recommended it to the Profession,. and it has since been generally used. The advantages alluded to in favour of chloroform are, that it is a more potent anæsthetic, its inhalation causes less bronchial irritation, its odour is more agreeable, it is less volatile, thereby rendering its administration more easy; and lastly, the vapour of chloroform not being inflammable like that of ether, it is fitted for operations by artificial light.

Chloroform.—This anæsthetic agent will be briefly considered in regard to:—its physiological action; the phenomena produced by inhalation; the question of its contra-indication in certain diseased conditions of the system; the method of administration; death from chloroform; and the treatment of an over-dose.

Physiological Action.—The action of chloroform on the functions of the nervous system is such as to render it exactly suitable for the purposes of surgical practice. Chloroform is a narcotic, and like most medicinal agents of this class, it produces temporary excitement, followed by suspension of the functions of the nervous centres; but it affects them not simultaneously, but in a certain order. The *brain* is the first to evince loss of power, in the failure of sensation, including consciousness, and voluntary motion; the *spinal cord*, or rather the whole cerebro-spinal axis, secondly, soon loses the reflex function of involuntary excito-motion so far as regards the voluntary muscles, which lie perfectly relaxed and passive. This combined state of insensibility to pain, paralysis of muscular action, voluntary, and involuntary with regard to the voluntary muscles, presents a condition most favourable for the performance of surgical operations. On the other hand, the *involuntary* action of the muscles engaged in respiration remains, and the action of the heart, as dependent on the ganglia of the sympathetic nerve, continues. Thus then, while the whole physiological condition of the nervo-muscular system suits the convenience of the Surgeon, and the patient is rendered insensible to pain; those dependent functional actions are retained which are essential to life.

Certain other important advantages attend the inactivity of the cerebro-spinal centre. The shock of injury, which would be increased by the additional violence of surgical operation, is diminished under the influence of chloroform; thence, the contractile power of the heart, as affected by the action of the brain and spinal cord upon the cardiac ganglia through the medium of the pneumogastric and sympathetic nerves, is unreduced by such violence, thus averting the tendency to *cardiac syncope* and death during operation; and lastly, in the absence of faintness, the vessels bleed freely, and by at once declaring those which require ligature, the liability of *secondary hæmorrhage* is prevented. Moreover, the mental tranquillity secured before operation by the pros-

pect of immunity from suffering, is a condition highly favourable to recovery afterwards. With regard to muscular action, anæsthesia sheds a relaxing influence of special advantage in all those operations where any such action would interfere with the requisite procedures; as in joint-excisions, amputations, ligature of arteries, herniotomy, colotomy, and other operations of abdominal section, and in operative procedures on the genito-urinary organs and rectum.

Phenomena or *Symptoms* produced by the action of chloroform.—After inhalation for a time, varying considerably in different individuals, but generally of longer duration in adults who have been accustomed to the free use of narcotics, and shortest in children, symptoms of excitement are manifested by various ejaculations, and by muscular rigidity and movements requiring some restraint; but this state is soon and suddenly succeeded by complete relaxation and insensibility, accompanied with deep, heavy respiration. Or, without any previous stage of excitement, the patient may at once pass into a state of tranquil sleep. The suspension of reflex action is denoted by the absence of unconscious winking when the eye-ball is touched with the tip of the finger, as a stimulus; a state commonly regarded as insensibility of the conjunctiva. The heart's action, and pulse, at first quickened and more forcible than natural, subsides under the influence of chloroform, and becomes slow and feeble or scarcely perceptible. The respiration also becomes feeble and imperfect, and the blood proportionately venous; a state approaching or bordering on asphyxia. Snoring or stertorous breathing is soon induced, passing into complete obstruction to the entrance of air into the chest, although the respiratory movements of the thoracic walls still continue. Occasionally, without any premonitory stertor, the breathing becomes more or less suddenly obstructed, and a livid turgescence overspreads the face. Death is imminent where inhalation is carried to this degree as regards either the circulation or respiration; and whether as the result of administering a highly concentrated vapour, or of long-continued inhalation.

There are instances occasionally of persons who, from some peculiar idiosyncrasy of constitution, are incapable of being affected by chloroform; they are proof against its anæsthetic influence. Thus, I have known four ounces of chloroform administered to a lady, by inhalation, without producing the slightest effect.

Contra-indications to the employment of chloroform.—Certain constitutional conditions and organic diseases, are said to prohibit the use of chloroform, or to require extreme caution in its administration. The influence of *shock* has already been adverted to, in speaking of the physiological action of chloroform. Pain is not a stimulant but a depressant, and therefore the performance of an operation during the continuance of shock, and without chloroform, would increase the collapse; and, moreover, as already explained, the influence of this agent protects the action of the heart from the tendency to cardiac syncope, resulting from the pain incident to an operation. Hence, operations may be safely performed, under the influence of chloroform, during the shock of injury; thus overturning the old rule of postponing operation, amputation for example, until the patient has recovered from the state of collapse. The system may be at once relieved from the injurious presence of a mangled limb, or life preserved where it would be hopeless to wait for returning consciousness. But, during shock, it

is unnecessary to give chloroform to its full extent; but only so far as to deaden sensation in the incisions or painful part of the operation.

Epileptic persons may be subjected to the influence of chloroform inhalation, administered cautiously, however, considering their liability to suffer from congestion of the brain.

Hysterical persons are said to be subject to laryngeal spasm, during inhalation.

Disease of the Heart does not absolutely contra-indicate the administration of chloroform, but only that it be given with extreme caution; watching the pulse especially, and the breathing. In *fatty degeneration* of the heart, the sedative influence of chloroform is liable to suddenly arrest the action of this organ with instant death. In *valvular* disease there is less danger.

Disease of the Lungs is not specially obnoxious to inhalation. In *phthisis*, not far advanced, no difficulty arises; but with bronchial irritation, troublesome cough is apt to be produced.

Disease of the Kidneys, resulting in degeneration of these organs, and the retention of urea in the blood, is a condition decidedly unfavourable for the administration of chloroform. Congestion of the brain being superadded to the uræmic-poisoning, may induce epileptic convulsions, with lividity of the face, stertorous breathing, and coma.

All *Surgical Operations* allow of the employment of chloroform, excepting a few in which the assistance of the patient is required, and in operations attended with copious hæmorrhage into the mouth. In some cases, however, pain may be prevented to a great extent, by giving chloroform during the earlier or more superficial parts of the operation.

Age is no objection to the employment of chloroform; infants and octogenarians taking it with safety.

Administration of Chloroform.—Prior to giving chloroform, the patient should be directed to omit taking food for four or five hours, as the presence of any food in the stomach is apt to cause troublesome vomiting during inhalation. The patient lying recumbent with the head and shoulders just comfortably elevated on a pillow, he should not be allowed to raise himself in any struggling excitement, or be raised, into the sitting posture whilst under the influence of chloroform, lest cardiac syncope take place. Any tight band round the neck or waist should be loosened, the breast had better be exposed, and care should be observed not to subject the thorax, or the abdomen especially, to any compression, as the respiration becomes principally diaphragmatic.

Chloroform may be administered simply on lint or a handkerchief, or by means of an inhaler of some kind. The former mode is in general use, it being equally safe, provided only two precautions be observed; the chloroform must not be given too suddenly, or the vapour breathed in too concentrated a state without a free admixture of air.

The mode of administration is simply this: a piece of lint or a handkerchief folded two or three doubles, and about the size of the hand, is sprinkled with a drachm or two of chloroform, measured from a graduated bottle; it is then held near the nostrils, but so as to admit a free admixture of air with the first few inhalations; after the lapse of about a minute, a towel may be placed over the face of the patient

and the hand of the chloroformist to enclose the vapour, still observing to admit the air freely under one corner or one-half of the towel. This is continued, interrupted perhaps by the temporary excitement and struggles of the patient, until the arm falls involuntarily and relaxed when raised, and the eyelid ceases to move when the conjunctiva is touched with the finger. During the course of inhalation, the chloroformist should have his other hand on the pulse, carefully feeling its force and frequency, while at the same time he unceasingly watches the breathing. If at any moment, earlier or later, during inhalation, the pulse sinks to a feeble, slow beat; or if the breathing becomes strongly stertorous; immediately discontinue the administration of chloroform; and for the relief of the respiration, at once seize the tip of the tongue, with forceps or the fingers, and draw it firmly forwards out of the mouth, until the tendency to obstruction has subsided. The breathing returns with perfect freedom, and the overshadowing lividity of the face disappears. Chloroform can then be cautiously re-applied, if necessary.

Inhalers of various kinds have been devised for the purpose of regulating the proportion of chloroform and the admixture of air. Snow's inhaler, or Clover's chloroform apparatus, may be employed; and the latter is spoken of very highly by those who have used it, as being most efficient. But simplicity with efficiency is always a great recommendation, and thus the administration of chloroform by means of a piece of lint or a handkerchief can be accomplished at once, when any form of inhaler may not be at hand and would have perhaps to be fetched from a distance of some miles. Even in Hospitals, inhalers are not commonly employed.

In point of safety, the two methods of chloroform administration are equally available, provided only that a free admixture of air be attended to. I have seen chloroform given in some thousands of cases without an inhaler, during about thirty years,—ever since its introduction, and both in Hospital and private practice, with only one death, or even an approach to a fatal termination, when the requisite precautions for safety have been observed.

Death from Chloroform.—During inhalation, death may occur from the failure of either of the organs which constitute the tripod of life; by asphyxia, by cardiac syncope, or by coma; through failure of the respiration from insufficient aëration, or by laryngeal obstruction; cessation of the heart's actions; or congestion of the brain.

Asphyxia is indicated by the ordinary symptoms: lividity and turgescence of the face, violent respiratory efforts, and cessation of the pulse, and of the heart's action. These symptoms may arise simply from deprivation of air resulting in a highly venous state of the blood; but stertorous or snoring breathing is superadded, when the asphyxia arises from laryngeal obstruction. The cause of this obstruction is generally attributed to a "falling back of the tongue," thus mechanically obstructing the entrance of air through the larynx. But Mr. Lister has specially investigated the question, and he finds that the obstruction arises from an approximation of the apices of the arytænoid cartilages towards, or to, the base of the epiglottis; the stertorous breathing resulting from the vibration of the corresponding portions of mucous membrane, the posterior parts of the arytæno-epiglottidean folds. Traction of the tongue firmly forwards abolishes the obstruc-

tion and stertor, not by any mechanical action on this part of the larynx, for the base of the tongue and hyoid bone remain unmoved in position. It would appear that such traction operates by reflex action through the medium of the nervous system, but whether by inducing or relaxing muscular contraction in the larynx, is uncertain.

Cardiac Syncope always occurs suddenly. The patient, after a few inspirations, suddenly becomes pale and faint, the pulse beating almost imperceptibly for a few moments, and then ceasing, although the respiration may continue; death taking place by paralysis of the heart. This organ may itself be healthy, but more frequently it will be found to have undergone fatty degeneration.

Coma presents the same appearances as asphyxia, but without failure of the heart's action. The face becomes livid, the breathing stertorous, and the body convulsed; the heart continuing to beat up to the last, as death results from congestion of the brain. This mode of death occurs mostly in epileptics, and in persons affected with uræmic blood-poisoning from old-standing renal disease.

These three modes of death are referable generally to the incautious administration of chloroform; whether as regards an excess of chloroform in proportion to the admixture of air, or the prolonged inhalation of this anæsthetic agent.

Persistent Sickness is another occasional cause of death; but it occurs *after* the administration of chloroform, and seems to be a consequence of some idiosyncrasy of the individual. I have only known one case, death having occurred from the exhaustion of continued sickness for four days after amputation of the thigh for encephaloid cancer of the knee-joint, in the person of an otherwise apparently healthy young woman. In another case, after excision of the knee for scrofulous disease, in the person of a young woman, sickness set in and continued for a week, but it was subdued by the hypodermic injection of morphia, while life was sustained by nutritive enemata.

The *after* effects of chloroform may, however, relate to the lungs or to the brain; congestion of one or other of these organs being attended with the unfavourable or even dangerous symptoms of a tendency to asphyxia or perhaps pneumonic dyspnœa, or of headache, tending perhaps to apoplectic coma.

Treatment of an Overdose of Chloroform.—The indication to be fulfilled will vary according as the symptoms, or apparent mode of death, arise from asphyxia, or from cardiac syncope; the object being to re-establish the respiration, or to stimulate and restore the heart's action and the circulation. But in either case, the following directions should be carried out immediately:—

The administration of chloroform must at once be discontinued.

Firm traction of the tongue must be immediately had recourse to, this being effected by seizing the tip of the tongue with fingers or forceps and drawing it well forward out of the mouth.

Air must be allowed to circulate freely around the patient, by opening the nearest window and the withdrawal of bystanders.

The chest, exposed and free of constriction, should be whipped or flagellated with a wet towel in order to stimulate reflex respiratory action.

This failing, artificial respiration should be resorted to; the best mode being compression with the hands just below the sternum, by a

sort of sharp concussive jerk, followed by relaxation for expansion of the thorax, while the tongue is still drawn out of the mouth.

Electricity may be employed as the last resource, by applying one pole of a galvanic battery over the spinous processes of the upper cervical vertebræ and the other to the præcordial region, so as to stimulate the respiratory and cardiac ganglia.

Friction of the extremities, and bottles or cans of hot water to the feet, may also be used, to promote the general circulation.

These means of resuscitation should be continued perseveringly while any sign of vitality remains, for it has happened that a patient irrecoverably dead, to all appearances, has thus at length been restored to life.

Sulphuric Ether has regained its original celebrity as an anæsthetic in America, its re-introduction into surgical practice having been accomplished mainly by the late Dr. Mason Warren, of Boston; and it seems not unlikely to be again brought into general use in this country. The advantages claimed for ether instead of chloroform are: the greater safety of that agent,—fewer deaths having occurred from its administration, and the less tendency to vomiting under its influence,—a decided superiority in many operations. Anhydrous ether produces insensibility nearly as quick as chloroform, thus being equally eligible in this respect. It can be administered most readily, without much loss of vapour, by means of an inhaler in the form of a cup-shaped receiver, fitted to the mouth and nose, and provided with a small air aperture. A piece of flannel is placed in the inhaler, and then saturated with a measured quantity of well-washed ether from a graduated bottle. The symptoms of anæsthesia, under the influence of ether, are similar to those induced by chloroform, but the stage of excitement is perhaps more marked. During the ensuing relaxation, whatever surgical procedure may be necessary, is performed.

Nitrous Oxide Gas has again been placed in the list of anæsthetic agents, chiefly by the advocacy of Dr. Evans, an American dentist in Paris. The action of this gas is speedy, but of questionable safety if continued longer than a few minutes, and of transient duration, sensibility returning almost immediately after the inhalation ceases. It is, therefore, specially adapted for operations of almost momentary pain, and which are not succeeded by immediate after-pain. Hence, the value of nitrous oxide gas in dentistry; while it is less serviceable in general surgery. The symptoms produced depend somewhat on the admixture of atmospheric air with the gas. Mixed with air, nitrous oxide is highly stimulating; excitement is rapidly induced, and of that lively and agreeable kind which originally suggested the name of "laughing gas." Unmixed with air, its inhalation is attended with no stage of excitement, but a state of profound coma is soon presented; and this being due to the almost asphyxiated condition of the patient, it is accompanied with turgid lividity of the face, and staring expansion of the nostrils. These alarming symptoms pass off with equal rapidity, when inhalation is discontinued, leaving generally no feeling of nausea or other discomforts. The gas may be conveniently inhaled from an india-rubber bag or balloon, of sufficient size to contain the quantity requisite for producing insensibility; and the dose can be repeated by refilling the bag from a cast-iron stock-bottle, provided with a stop-cock, the gas having been rendered portable by condensation in the liquid form.

Bichloride of Methylene and *Chloral Hydrate* are anæsthetic agents which have more recently been added to those already noticed—nitrous oxide gas, sulphuric ether, and chloroform. For this addition we are indebted to the experimental researches of Dr. B. W. Richardson.

Bichloride of Methylene, compared with chloroform, has certain alleged advantages; anæsthesia is rapidly induced, and it can be maintained for any length of time, without also any muscular excitement or rigidity, recovery is rapid and complete, and without any unpleasant after-symptoms. Sickness, however, is not less liable to occur from the influence of this agent when continued beyond a few minutes. In point of safety, it seems to be about equal to chloroform. According to Dr. Richardson's estimate, up to October, 1869, bichloride of methylene had been administered to between six and seven thousand persons with only one fatal termination. It occurred in a patient of Mr. Canton's, on whom he was about reluctantly to operate at Charing-Cross Hospital, for advanced malignant disease of the upper jaw. The patient, a man thirty-nine years of age, was previously exhausted, bodily and mentally, by great suffering of three months' duration, the apparent date of the disease; one nostril was closed by the tumour, thus obstructing respiration, and the patient was subjected to the influence of the bichloride in a sitting posture. One drachm and a half, in separate quantities, had been administered, when the man's head fell back, the pulse became feeble, and then ceased. There was no accompanying stertor nor lividity of countenance. The horizontal position, artificial respiration, and galvanism, failed to restore life. Other fatal cases have since occurred. Mr. Rendle, of Guy's Hospital, observes that the rapid action of bichloride of methylene,—in twenty or thirty seconds,—and the rapid recovery from its influence, are apparently due to its great volatility and solubility, enabling a large quantity to reach and escape from the nerve-organs at once; while its safety is referable to its rather stimulant action on the heart, and to its speedy elimination. The bichloride, being very volatile, should be kept in a well-stopped bottle, placed in the dark, and inverted under water. Mr. Rendle's inhaler consists of a leathern receptacle, dome-shaped, and perforated for the admission of air; having also an accurately fitting mouth and nose piece. This inhaler is lined with a loose flannel bag, fastened round the mouthpiece by an elastic band. A drachm dose of the bichloride of methylene is scattered over the interior of the flannel bag; the vapour should then be administered cautiously, with a sufficient proportion of air not to induce anæsthesia under one or two minutes; and as sensibility returns in only a few minutes, the effect of the bichloride may be maintained by giving another drachm, if necessary, observing to discontinue the inhalation immediately, in the event of dangerous symptoms,—namely, cessation of the pulse and respiration, with turgid lividity of the face.

This anæsthetic agent is employed chiefly in operations on the eye, as at the Ophthalmic Hospital, Moorfields, and in the Ophthalmic Wards at Guy's Hospital; also in Ovariotomy, by Mr. Spencer Wells, at the Samaritan Free Hospital, where I have seen it used very satisfactorily. In general surgery, to save time, bichloride of methylene is sometimes administered in order to rapidly induce anæsthesia, which is then continued under chloroform.

Chloral Hydrate is, by some observers, said to possess powerful

anæsthetic properties; others deny that it is an hypnotic or anæsthetic, but regard it as a powerful excitant. I have found its action to be very uncertain.

Local Anæsthesia.—The application of cold to a part of the body, in order to reduce the temperature of that part to a frost-bitten condition, is a mode of anæsthesia which may be advantageously employed in certain surgical operations. It is eligible in all superficial and limited operations, in regard both to their extent and the time requisite for their performance. Such are, the avulsion of a toe-nail, puncturing abscesses, slitting up fistulæ, and the excision of small tumours.

Freezing of the part operated on may be effected either by the application of a frigorific mixture, as introduced by Dr. J. Arnott, or by the ether-spray, devised by Dr. B. W. Richardson.

The frigorific mixture of pounded ice and salt is easily made, and answers admirably. This mixture is put into a muslin bag, and applied to the part, being raised in a minute or two to see whether the desired effect has taken place. The skin almost immediately loses its colour and becomes white, a change the more observable when previously reddened by inflammation; but this blanching of the skin is no sign of freezing having occurred; soon, however, a dead white, opaque spot appears, quickly spreading over the cutaneous surface, and then the part is frozen and anæsthesia produced. The integument cuts hard, like parchment, and the blood is singularly florid. Reaction speedily sets in, the part bleeds freely, and often becomes very painful. But no constitutional disturbance accompanies, or ensues from, this freezing of a part of the body. I have seen or known only one case of any unfavourable consequence. The patient, a healthy, florid young woman, had sat and seen me remove one of her great toe-nails, looking at the operation with perfect indifference; but when reaction took place, she suddenly fainted, and again and again, until the syncope was alarming.

The *Ether-spray* is another means of freezing a part and inducing local anæsthesia; but in this method it is effected by evaporation of ether thrown upon the surface in the form of a fine spray from a little apparatus contrived by Dr. Richardson for the purpose. It offers a more ready method for the convenience of surgical practice, as it may always be kept at hand; whereas ice cannot always be obtained. Unfortunately, so far as my experience has gone, the apparatus, simple in itself, usually seems to be out of working order when wanted.

Dangers attending, or consequent on, Surgical Operation.—The perils pertaining to operation are principally as follows:—(1) Hæmorrhage, primary and secondary; (2) Shock; (3) Exhaustion; (4) Tetanus; (5) Inflammation; (6) Gangrene; (7) Erysipelas; (8) Pyæmia. Of these different contingencies, some are coincident with, others consequent on, the operation. They will all be fully considered in various chapters of this work.

Dressing of the Wound, and Constitutional After-treatment.—The dressing of a wound made by surgical operation is the same as that of an Incised Wound, or Amputation-Stump; and the dressings will vary with the supervention of Inflammation, and its consequences—Suppuration, Gangrene, and Ulceration. The Constitutional After-treatment must have reference to the various states of the system in the contingencies already alluded to; and to those resulting from

Inflammation—namely, Inflammatory Fever, Hectic, and Gangrenous-typhoid febrile disturbance. All these states also are considered in their appropriate chapters.

Results of Operation.—The object or purpose of any Surgical procedure should be viewed with regard both to its temporary and its permanent results. An operation may be successful from the one point of view, but not from the other.

The unsuccessful results of any Surgical procedure may, perhaps, be reduced to three general heads:—(1) A return of the original condition for which the operation was performed; (2) the substitution of some new condition, not better, or worse, than the first; (3) the inducement of disease in some distant part of the body. Of the two first modes of unsuccessful results, such instances may be cited as, after amputation of a limb, the return of gangrene in the stump; after excision of a joint, the substitution of a useless limb. The third mode of unsuccessful result is illustrated, after ligature of an artery for aneurism, by the development of aneurism in another part; or after the excision of cancer-growth, the development of internal cancer.

Statistics in Surgery.—To properly estimate the facts gained by observation, whether in the Science or the Art of Surgery, we must *count* them. The impressions of experience so called, respecting pathology and treatment, are too vague and indistinct for any trustworthy conclusions. Accuracy of observation is essential to reliable results, and the number of observations taken is also a very important consideration. Hence, the value of Statistics, or the Numerical method of inquiry; which, by the process of counting, imposes a rigid check upon any dissimilarity of the facts thus enumerated by units, and estimates their evidential significance by their number,—absolute, or relative to other series of facts with which they may be compared and weighed. It is sometimes said of Statistics, that anything can be proved by figures, for or against a given question at issue. The fallacy of this assertion is demonstrated by the very process of counting, as the corrective of erroneous data. The numerical method may, indeed, seem dry and unattractive to persons of an imaginative disposition, for its inherent exactitude imposes on such persons a disagreeable restraint. But, as men of Science, and Students or Practitioners of an Art involving the tremendous issues of life and death, truth should ever be our first consideration. And, for the fruits accruing from well-assorted collections of facts, and their comparison, I may point to the very important results which have thus been achieved in many departments of Surgery, as exhibited in the course of this work.

PART I.

GENERAL PATHOLOGY AND SURGERY.

DISEASES OF NUTRITION.

CHAPTER I.

INFLAMMATION.

Inflammation may be defined to be a local modification of Nutrition; consisting, essentially, in an increased textural productiveness and destruction of texture, and *acceleration*, therefore, of the nutritive process; resulting in an accumulation of mixed, organized matter,—partly, of products having an imperfect structural homology or resemblance to healthy conditions of texture or textural elements, and partly, of débris or waste of the textures involved. In connection with this process of accelerated and imperfect nutrition, the local circulation of blood, and the containing vessels, undergo certain changes; an increased flow or *determination* of arterial blood to, and in, the capillary vessels, at the seat of inflammation, stagnation and accumulation or *congestion* of blood in the capillaries of the inflamed part, the veins transmitting the increased current of blood through collateral capillaries, with enlargement of all the vessels concerned; vascular changes which are accompanied with an effusion or exudation of organizable plasma or liquor sanguinis. The condition of the local circulation in the capillaries is known as the *stasis* of the circulation in an inflamed part.

This complex process has the most comprehensive significance, both pathological and practical; having relation to all Injuries, Diseases, and Surgical Operations. Hence, a due knowledge of Inflammation and its consequences, is of primary importance in the study of Surgery.

The pathology of Inflammation is most appropriately introduced by a brief consideration of the physiology of healthy Nutrition,—in the maintenance of the structural integrity of the body, and the modifications of this process in growth and development.

Nutrition is that process, wherein the blood or its constituents as nutritive material—liquor sanguinis, plasma or blastema—is converted into the various textures and organs of the body; thereby restoring or repairing the loss or waste of their structure, which continually accompanies the exercise of their respective functions. The changes which

the nutritive material undergoes are of two kinds:—chemical, in respect to its composition, plastic or formative, as productive of structure; analogous but opposite changes taking place in the course of decomposition and destruction of the textures.

In any diseased modification of Nutrition, as Inflammation, the process is essentially the same in kind, differing only in degree. Hence, the products or structural results, and their appearances in course of destruction, are the same, differing only in character. Parallel, but apparently less definite, modifications of chemical composition, may be inferred.

The process of Nutrition may be traced, to some extent, in certain tissues, which, being situated on the surface of the body, are open to observation. Epidermic tissues, namely, scarf-skin or cuticle, nails and hairs, are thus patent. The cuticle, for example, is a layer of cells overlaying the vascular and sensitive true skin. From the latter, a thin, and nearly transparent, serous fluid perpetually exudes, and in this, as a nutritive plasma or blastema, the cuticular cells are formed.

Let a portion of cuticle be removed by a blister or a slight burn; the exposed surface is found to be constantly bathed with this fluid. If lightly sponged dry, the surface immediately perspires, as it were, and moistens again. The cells, first formed in this fluid, are soft and round, as seen under the microscope, in newly formed cuticle. They are also soluble in acetic acid. They give place to similar cells underneath, and as the first formed pass upwards from the true skin, they become dry, hard, and flattened, and acquire the characters of ordinary scaly epithelium; which eventually disintegrates and desquamates from off the surface of the body. A chemical change also accompanies the maturation and destruction of cuticular cells; in this stage, they are insoluble in acetic acid.

This twofold process—formative and destructive—is ever going on; the cuticle being produced, and reduced more or less perceptibly by the decay, death, and shedding of the cuticular cells; they having previously served their function of protecting the subjacent true skin.

Molecular disintegration and death, by the constant exercise of function, may be inferred, if not seen, to be proceeding in all other tissues. But constant waste, thus induced, implies constant repair, and the reparative material can only come from the blood. This vital fluid must, therefore, present an appropriate composition for the repair of each component tissue of the body, and must also be supplied in adequate quantity thereto, as all the tissues are alike undergoing incessant destruction.

Assuming this twofold condition of quality and quantity of blood, due to the tissues severally; they, on their part, select and secrete or separate from the blood-vascular system, as the common reservoir, that kind and quantity of plasma which is appropriate for their individual nutritive maintenance. The blood is thus left reduced in quantity, and, moreover, deprived of those constituents which have entered into the formation of the tissues. But, as each tissue draws its own particular nourishment, the residual mass of blood, in circulation, becomes relatively adapted, in quality, for the proper nourishment of other tissues, of dissimilar composition. The tissues, severally, in their functional relation to blood-elaboration, may therefore be regarded as excreting organs.

The blood is renewed in quantity, and further maintained in quality, by the co-operation of other functions,—digestion, excretive secretion, and respiration; while its circulation is regulated by the agency of the nervous system. Again and again is this fluid, replenished and renovated, distributed to every part of the body, each tissue claiming and retaining that quantity of the common pabulum which may be necessary, and selecting those ingredients which enter into its own formation, to repair its waste and thus maintain its substance.

Growth and Development.—It will be obvious that any increased nutritive demand, beyond that of mere maintenance, as by Growth, necessarily implies at least an increased supply of blood to the part undergoing this change, and perhaps also a different quality of blood to meet any such additional requirement. Indeed, ever moving and vibrative as are the leaves of an aspen tree even on a breathless summer's day, so likewise oscillatory is the nice adjustment and equilibrium of nutrition. The balance of maintenance could never be continued from hour to hour, scarcely from minute to minute, without a varying capacity in the circulatory system to satisfy ever-varying demands. This provision is brought into action by nervous influence.

It is now known, originally by the experimental researches of M. Claude Bernhard, that the circulation of the blood is influenced by vaso-motor nerves—*nervi-vasorum*—forming a wide expanse of the nervous system, distributed to the blood-vessels, principally to the arteries, and extending even to their ultimate ramifications. This vascular system of nerves is derived, in part, directly from the sympathetic or ganglionic system, as from the splanchnics, which are the vascular nerves of the abdominal viscera; and in part, indirectly, by communicating branches between the sympathetic cord and the anterior roots of the spinal nerves, as the source of nerve-supply to the blood-vessels of the extremities, upper and lower. But, while the vaso-motor system of nerves thus proceeds from the sympathetic, its primary origin is in the cerebro-spinal system; isolation of any portion of the sympathetic, by division of its spinal communicating branches, being attended with paralysis of its vaso-motor functions. There is also, apparently, an excito-motory *centre*, presiding over the whole vaso-motor system of nerves; for the motor influence of these nerves on the blood-vessels can be elicited by stimulating afferent spinal nerves, being therefore reflected by that centre, through efferent sympathetic vascular nerves. The situation of the centre here referred to is *intra-cranial*,—the vaso-motor influence ceasing when the spinal cord is divided immediately below the medulla oblongata, and thereby causing paralysis of the whole vascular system. The most important results respecting the physiology of the vaso-motor system of nerves, as shown by the effects of their stimulation or their division, are thus summarily stated by Dr. Burdon Sanderson:—That section of a vascular nerve produces congestion of all the tissues to which it is distributed; that excitation by the interrupted current, or by mechanical means, produces constriction of the minute arteries presided over by the irritated nerve, and consequent anæmia; that excitation of a sensory nerve produces increased activity of the capillary circulation in the part in which the nerve originates; and that all arteries exhibit alternating states of contraction and dilatation, their rhythmical

movements being entirely independent of those of the heart and the respiration, and ceasing when the vessel is paralyzed by division of its nerves.

Development contrasts with growth, in representing the quality, as well as quantity, of structure produced. But the two are concurrent and co-equal manifestations of the formative power, in healthy Nutrition.

It would appear that emotional influence is not limited to apportioning the supply of blood, and thence the quantity of growth or the size attained by a part subject to such influence; the *quality* or kind of growth produced is also, in a measure, regulated thereby. A fatty tumour was removed by Mr. Lawrence, several years ago, from a woman's shoulder; and when the wound had healed soundly, she imagined the tumour to have been a cancer, and that it would return. Mr. Paget saw her some months afterwards, and she had a large and firm painful tumour in her breast, just like a portion of indurated mammary gland. She was assured by Mr. Paget that her supposed cancer would disappear; and it did become very much smaller, without any help from medicine. As this tumour had arisen under the influence of fear, so it very nearly subsided under that of confidence. The patient was lost sight of before the tumour had been completely absorbed.

In this summary of the process of Nutrition, we observe a co-operative relation subsisting between its essential conditions:—textural changes; and the blood, in quality and quantity, as representing the nutritive material; accessory to which are the blood-vessels which convey the blood to the part nourished; and the nerves in connection therewith, which further regulate the supply. The accessory character of the two latter conditions is also evinced by the fact of Nutrition taking place in comparatively avascular textures, and those which are destitute of nerves; as cartilage. Thus, then, is Nutrition maintained; and we also observe in these conditions adequate provision for the extra demands of Growth and Development, whereby blood is duly determined to textures or parts undergoing this twofold physiological change.

Reparation of texture, after destruction by injury or disease, is subject to the same conditions. The processes of immediate union, primary adhesion, suppurative granulation, with perhaps secondary adhesion, and scabbing, as described in subsequent chapters, may therefore be properly associated with this general consideration of the physiology of Nutrition.

Inflammation is another modification of Nutrition, the same elements co-operating. This process can be observed when it takes place in textures on the surface of the body, as the skin; and it is best illustrated when occasioned simply by a burn or other injury, rather than when induced by the operation of a blood-poison, as in erysipelas, boil, or carbuncle, which are specific and complicated illustrations of inflammation.

(1.) *Textural Changes.*—The twofold nature of the textural changes in Inflammation, is the same as in healthy Nutrition; but the textural productiveness, and the destruction of texture, are both increased; and the process proceeds more rapidly. Hence, the products are not only increased in quantity, they are also imperfect structural conditions of

textural elements, by various degrees of arrest of their development; such as exudation and pus-corpuscles, coagulated fibrin with plastic corpuscles, granular matter, and serum; while the *débris* or waste matter of the texture is apt to accumulate.

In virtue of its increased productiveness, inflammation differs from nutritive maintenance, and is allied to growth; but in virtue of its rapidity, the process is so hurried on, that more is accomplished in a given time, and consequently the products are imperfectly developed. Accelerated Nutrition would therefore, I think, be an appropriate name for Inflammation, as at once expressing its nature and distinctive character.

Experimental investigations have been instituted, chiefly by Professors Cohnheim and Stricker, with regard to the changes which the textural elements undergo in inflammation. Non-vascular tissues are best adapted for the observation of such changes,—apart from the blood-vessels and circulation; as the cornea of the frog, cartilage, and tendon, under the influence of irritation by caustic or a seton-thread. But vascular tissues, as connective tissue in the frog's tongue, muscle, mucous membrane, and gland tissues, especially that of the liver, have also been submitted to similar examination. The general results have been—that the textural changes represent increased activity of cell-life, in the proliferation or germination of protoplasm or of cells, which multiply either by cleavage or by endogenous germination. Whether this increased textural productiveness be due to the direct stimulant action of the material effused from the capillary blood-vessels, or be referable to nerve-influence, may be regarded as an open question.

(2.) *State of the circulation of blood*, and of the *blood-vessels*, in relation to, and in, the part inflamed.—This element of inflammation necessarily pertains to vascular textures; nevertheless, comparatively avascular textures, such as cartilage, which are nourished by imbibition, are affected by the circulation of blood in the adjoining texture, whence they derive their nutritive material as the source of supply.

The blood current to, and from, an inflamed part, through the arteries and veins respectively, is increased in quantity, force, and rapidity; so also it would appear to be primarily increased in the capillaries of the part, but secondarily it becomes stagnant, a condition known as the *stasis* of the circulation in those vessels. The arteries, veins, and capillaries all apparently become enlarged.

Enlargement of the arteries, with increased flow of arterial blood through them, constitutes *determination* of blood; enlargement of the capillaries, with stagnation or accumulation of blood in them, constitutes *congestion* of blood; the enlarged veins transmitting the increased current of blood, through collateral capillaries.

In inflammation, the presence of determination of blood, subsequently of congestion, and the co-existence of both these vascular conditions, are facts which have been more or less established by the following experimental observations:—

(*a.*) *Arterial and Venous Circulation.*—The arteries towards an inflamed part throb with increased pulsation, while the veins therefrom are turgid. It might appear that the former are beating with blood apparently rebounding from some obstruction in advance, and that the latter become turgid with stagnant blood. But experimental observa-

tions demonstrate the accelerated rapidity and force of the blood's motion to, and from, an inflamed part.

Let an artery toward a part inflamed be divided, and the blood is seen to be ejected to a much greater distance than that from an artery of the same size and distance from the heart, but not contiguous to an inflamed part.

This increased propulsion was noticed by Dr. John Thomson, when the arteries of a finger were divided in whitlow, and when those of the prepuce, much inflamed, were cut in the operation for phimosis. More exact, because comparative and otherwise complete, was the observation of Mr. Lawrence. One hand of a patient being inflamed, venesection was performed, at the same time, and in a similar manner, in both arms: the vein from the inflamed hand yielded about three times more blood in a given time than the vein from the uninflamed hand. The blood's motion from the part was increased.

Enlargement of the arteries leading to an inflamed part, in the human subject, is rendered probable by Hunter's well-known experiment on a rabbit. Hunter froze the ear of a rabbit, and thawed it again; acute inflammation began, with increased heat, and considerable thickening of the part. The rabbit was killed when its ear was at the height of inflammation. The head was then ejected, and the two ears were removed and dried. The uninflamed ear dried clear and transparent; its vessels were distinctly seen ramifying through its substance; but the inflamed ear dried thicker and more opaque, and its arteries were considerably larger.

(*b.*) *Capillary Circulation.*—The state of the capillary circulation in inflammation has been observed in the transparent parts of certain of the lower animals, chiefly in the web of the frog's foot, or in the mesentery of that animal, and in the bat's wing. Conclusions drawn from such data relative to the human organism, are inferential only, the physiological and structural conditions being dissimilar. Yet these inferential conclusions represent the remainder of what is known respecting the nature of inflammation, in the human subject.

Determination and *Congestion* of blood co-exist at the seat of inflammation. Dr. C. J. B. Williams was one of the earliest observers who demonstrated this conjunction of increased and diminished *motion* of the blood in the capillary vessels in inflammation, and also that the resulting compound state of the capillary circulation may originate either in determination or in congestion, or in the concurrence of both simultaneously.

To illustrate the origin of inflammation by the concurrence of determination of blood and congestion, Dr. Williams adduces experimental observations on the web of the frog's foot, under the microscope. "If," says he, "a strong irritant, as a grain of capsicum, or a minute globule of essential oil, be applied to the web, all its blood-vessels speedily become enlarged; those most irritated are very large and red, and the blood in them is stagnant and coagulated; contiguous vessels are also very large, but less red, and the motion of the blood in them is slow, and often in pulses or oscillations; whilst in vessels beyond, the enlargement of the capillaries is less considerable, but that of the arteries is obvious, and the current of blood is very rapid."* The general enlargement of the capillary vessels is well shown in the bat's wing;

* "Principles of Medicine," Edit. 3rd, 1856, p. 323.

where, as compared with their natural condition, before irritation (Fig. 1), the vessels have become dilated to nearly twice their diameter, and many more have become visible within the area of the focus of irritation. (Fig. 2.)

Fig. 1.*

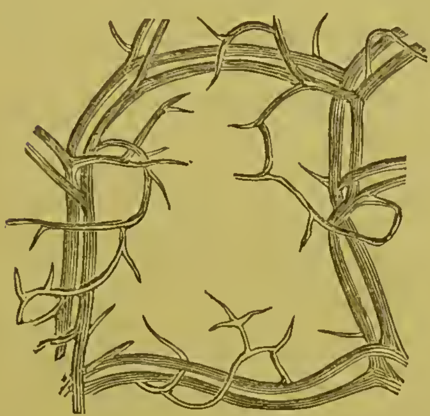
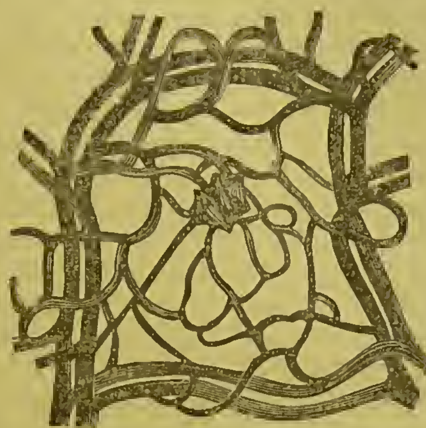


Fig. 2.*



The *vessels* having undergone dilatation, they may become sacculated, lengthened, and tortuous, as the result of their weakened and inelastic state from over-irritation, in an advanced stage of inflammation (Fig. 3); and the *blood* contained in the vessels undergoes certain changes, the red corpuscles being impacted, accompanied with an increased production, apparently, of the pale corpuscles, which also appear to be more adhesive, and cling to the sides of the vessels. The capillary circulation of a warm-blooded animal, as in the bat's wing, when thus subjected to irritation, does not exhibit any increased proportion of white corpuscles, according to the observations of Wharton Jones and Paget; and in the frog, that condition may be due to an unhealthy state of this animal. Dr. Williams' original description has more recently been confirmed essentially by Dr. Burdon Sanderson, and other observers; —that, in inflammation, the vascular phenomena consist of "increased activity of the capillary circulation in the affected part, followed by diminished circulation;" or conversely, that the vessels may become contracted, in the first instance, followed by dilatation; this difference depending on the kind of irritant employed, as a solution of ammonia, while a solution of caustic soda produces dilatation succeeded by contraction, and croton oil seems to have a variable effect on the vessels, sometimes producing the one, sometimes the other.

Fig. 3.†

The leading vascular change in inflammation—acceleration of the capillary circulation—is referable to an impression received by the cen-

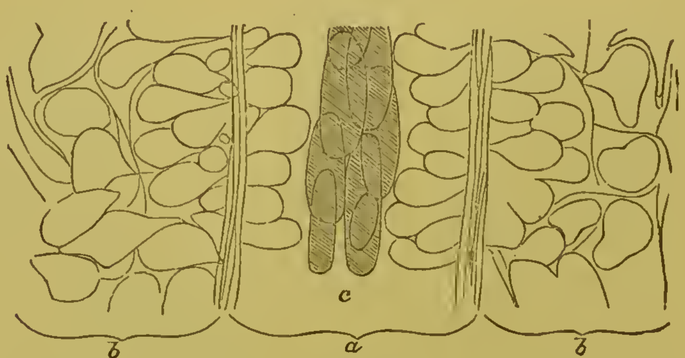
* (Wharton Jones.)

† (Paget.)

tripetal nerves of the injured part, and reflected by the vaso-motor centre through the centrifugal nerves to the vessels. This physiological explanation rests on the observations of Ludwig and Lovén; in curarised rabbits, excitation of the central end of a divided nerve in the external ear, or of the dorsal nerve in the foot, was noticed with regard to its effects on the corresponding artery; and similar experiments on the sciatic nerve of the frog, relative to the circulation in the web of the foot, were conducted by Stricker and Riegel, and repeatedly verified by Dr. Sanderson.

Emigration of blood-corpuscles through the walls of the Capillaries.—In the course of Inflammation, the passage of blood-corpuscles through the walls of capillary vessels, seems to have been been originally noticed by Dr. W. Addison (1842), and more completely described by Dr. A. Waller (1846); but this remarkable fact first attracted attention by the observations of Professor Recklinghausen (1863), Professor Stricker (1865-6), and specially by the investigations of Professor Cohnheim (1867) and Dr. Prussak; more recently confirmed in this country by Dr. B. Sanderson. Experimental observations upon the transparent parts of animals, as the foot-web, or the mesentery of the frog, or the tongue of that animal, have been the source of our knowledge in this important physiological inquiry. The *process* of emigration in the passage of *white* corpuscles, or *leucocytes*, is as follows:—The

Fig. 4.*



corpuscles having accumulated within the capillary vessels, those which lie on the interior of the vessel begin to sink into the capillary wall, presenting button-shaped projections externally (Fig. 4); gradually enlarging in the shape of pyriform bodies, the imbedded corpuscles pass through the wall, but are still adherent by their pedicles; lastly, becoming detached, the passage is completed, and the corpuscles—which have thus emigrated from within—are each free outside the vessel. The *red* corpuscles may emigrate in like manner, though less abundantly. The cause of this migratory process seems to be, that the cells possess an inherent vital activity—that of protoplasm, and resembling the mobile power of *amœbæ;* and that the capillary walls also possess the same contractile power of protoplasm, in addition to their vital capacity for proliferation, as evinced in the ramifying formation of new vessels, and, moreover, the physical

* Mesentery of living Frog.—*a.* Vein. *bb.* Adjoining connective tissue permeated by colourless corpuscles, which have migrated from the vessel. *c.* Central column of red corpuscles. $\frac{1}{500}$. (Cohnheim.)

properties which had long since been known. Thus, then, the capillary vessels and the blood-corpuscles, white and red, are apparently alike endowed with the power of amœboid activity; and thence the emigration of the corpuscles in the process of Inflammation.

In tracing the process of Inflammation, it is difficult to determine the *order of succession* in the changes which essentially constitute this process. The question of priority, therefore, on the part of the textures or blood, is doubtful. Whether an increased textural productiveness, and consequent demand for nutritive material, induces an extra flow of arterial blood towards this focus of accelerated nutrition; or whether a determination of blood solicits the formative power of the textures to more active, albeit abortive operation?

The latter view, originally advocated by John Hunter, long held undisputed acknowledgment in the schools and in medical literature; before the textures were discovered, so to speak, by Bichat, and before the grand and fertile theory of cell-development introduced by Schwann and Schleiden. But the independent vitality of the textures in relation to the blood, a physiological doctrine probably entertained by Haller, was subsequently extended to pathology by Hebrenstreit, Burdach, Alison, and others; while, in respect to Inflammation especially, this doctrine is strenuously advocated with great originality of argument by Virchow, and exclusively adopted by Mr. Simon and other pathologists in recent works.

For the discussion of any other doubtful points respecting the intimate nature of Inflammation, and more particularly as investigated in animals, the reader is referred to abundant sources of interesting information in the writings of Wilson Philips, Kaltenbrunner, Gerber, Gendrin, Müller, Lebert, Alison, Henlé, Macartney, Addison, Gulliver, Wharton Jones, C. J. B. Williams, Bennett, Paget, Lister, Virchow, Billroth, Cohnheim, Stricker, Simon, and Burdon Sanderson.

Signs.—The local signs of inflammation—as enumerated from time immemorial—are redness, heat, swelling, and pain; the first three being objective phenomena, pain a subjective symptom; and there is also some functional disturbance or loss of functional power in the part affected.

(1.) *Redness* is a sign of inflammation, owing to the determination of arterial blood; but the development of this sign will be proportionate to the number of capillary vessels pervading the part, and the extra flow of blood through them. The colour, a florid hue, varies according to the arterial or venous character of the blood, and as shaded by any intervening texture; or it may be entirely unseen through the depth of integument concealing the engorged vessels. Various shades of redness are met with in different inflammations: a bright crimson hue in acute inflammation; a darker or purple tint in the chronic form; a damask redness in erysipelas, or a brownish lividity in phlegmonous erysipelas; a yellow redness when associated with jaundice; a copper hue in syphilitic inflammation; a purplish lividity, deepening into black, whenever inflammation becomes gangrenous. The vascular engorgement, or hyperæmia, presents different shapes, according to the peculiar anatomical arrangements of the capillaries in the texture or part. Hence punctiform, stellate, arborescent, maculiform, or spotted, and uniform blush-redness, are frequently recognized, as in the skin and mucous membranes which

are open to inspection. The redness may be circumscribed, as in phlegmonous inflammation; or diffused, as in the erysipelatous. Hæmorrhagic redness, arising from the interstitial extravasation of blood, in the form of spots or petechiæ, may be an accidental coincidence with, or result from, inflammatory engorgement of the capillary vessels; but increased redness from this source will be readily distinguished from that of inflammation, the one remaining under pressure with the finger, the other disappearing when the engorged vessels are thus emptied.

Persistent redness, such as I have described, is the earliest announcement of inflammation, and also its most exact indication, being invariably present even when unseen, a sign of no other kind of hyperæmia, and the measure of its own. The exceptional case of a growing part, *e.g.* new bone, or the gravid uterus, having similar redness, scarcely invalidates the general fact that this sign is, otherwise, peculiar to inflammation. Nor does its exceptional absence in extra-vascular tissues, *e.g.* cartilage and the cornea, affect the otherwise general constancy of this hyperæmia. Even in such cases the adjoining textures exhibit its characteristic appearance, as by a zone of redness around the cornea, in corneitis, and increased vascularity of the adjoining bone, in inflammation of cartilage. In either case, the seat of hyperæmia coincides with the capillary plexus which is subservient to the healthy nutrition of the part inflamed.

Redness from the development of new vessels in an inflamed part is not an early occurrence, but a consequence of the process of inflammation.

(2.) *Heat* is another local sign, partly due to the determination of blood; as such it is proportionate thereto, and to the number of vessels through which the extra supply of arterial blood is passing. But the increase of temperature will be perceptible only according to the superficial situation of the inflamed part, and the facility with which heat is transmitted through any intervening textures.

Is heat generated by inflammation? The flow of arterial blood, and therefore of red blood-corpuscles charged with oxygen, may possibly generate heat. Yet the experiments of John Hunter show that the temperature of an inflamed part never rises more than two or three degrees, and scarcely, if ever, above the average heat of arterial blood—say, from ninety-eight to one hundred degrees Fahr. On the other hand, the experiments of Becquerel and Breschet, and the more recent "thermo-electric" observations of Mr. Simon and Dr. E. Montgomery are apparently conclusive on this point—that an inflamed part is no mere passive recipient of heat, but is itself actively calorific. For among the observed results are these:—

"That the arterial blood supplied to an inflamed limb is less warm than the focus of inflammation itself.

"That the venous blood returning from an inflamed limb, though found less warm than the focus of inflammation, is warmer than the arterial blood supplied to the limb; and,

"That the venous blood returning from an inflamed limb is warmer than the corresponding current on the opposite side of the body."

Granting, then, that the inflammatory process unquestionably involves a local production of heat, "to interpret this fact," adds Mr. Simon, "is perhaps, in the present state of physics, not possible."

Whatever be the source of increased heat, it continues with the inflammation, unlike the transient warmth of blushing, or other non-inflammatory determination of blood.

Respecting its diagnostic value, the increased heat arises at the same time as the redness; it is an equally early, if not an equally exact sign of inflammation.

(3.) *Swelling.*—The persistent or inflammatory determination of blood is accompanied with the appearance of coagulable lymph or fibrin, and serum,—constituting what is known as *effusion* or *exudation;* which by its accumulation in the part, and augmented by increased textural productiveness, or proliferation of tissue, in both ways gives rise to swelling in a greater or less degree; unlike the issue of that temporary distension of the vessels, which ordinary determination of blood denotes.

From a persistent increased flow of blood, the surcharged vessels would appear to be gradually relieved by effusion of the liquor sanguinis.

Virchow regards the fibrin, not as an exudation or effusion from the vessels, but as an educt from the vessels, in consequence of the activity of the histological elements themselves. Professor Bennett suggests that the tissues attract the fibrin, which, however, pre-exists in the blood.

The engorged vessels themselves occasion some degree of swelling of the part; an increase proportionate to the vascularity of the part, and to the degree of turgescence of its vessels. Full-blooded internal organs become most swollen in this way, such as the lungs, liver, spleen, and kidneys when inflamed. But with persistent engorgement further enlargement ensues by effusion, and the situation, size, shape, consistence, and physical characters generally of this swelling, will, for the most part, depend on the kind of structure in which it takes place.

Liquor sanguinis is readily effused into the constituent cellular texture of the organ, or part inflamed, and therefore most readily into the substance of loosely parenchymatous organs; frequently, moreover, the most vascular, such as those just enumerated. Lymph and serum overflow into cavities, *e.g.* into serous membranes and synovial sacs. These and similar structures solicit the overloaded vessels to relieve themselves, and their size becomes enlarged, in a corresponding measure, by inflammation. Witness hepatized lungs from pneumonia in its second stage; immense enlargement of the liver from chronic inflammation; enormous increase of the spleen, forming the ague-cake by an analogous process; and the large size to which the kidneys attain by chronic nephritis and Bright's disease. Phlegmonous erysipelas—engaging, as it does, the subcutaneous cellular tissue deeper and deeper—is characterized by considerable swelling. Witness the opposite results in tight, unyielding textures—such as effusion beneath fasciæ and in fibrous textures generally, and an abscess formed in the substance of bone, but unattended with any perceptible swelling, and suspected only by the intense and unremitting pain it occasions. Certain textures allow of an intermediate amount of swelling between the extremes presented by cellular and fibrous tissues. Such are the degrees peculiar to the skin and mucous membranes. Of the latter I may mention pulpy thickening of the large intestine in cases of chronic dysentery; while swelling, in some measure, of the skin is one feature

of most of its eruptions, however otherwise diversified their appearance may be—as rashes, scales, papules (pimples), vesicles, pustules; and most conspicuously is this the character of solid tubercular swellings, such as occur in secondary syphilis.

The shape of inflammatory swelling is also a mixed result, principally due to the kind of structure into which effusion takes place; partly, however, to the kind of matter effused. If thin serum, the swelling will be fluid, fluctuating, and diffused; if coagulable lymph be poured out, it will be more solid and circumscribed. I shall not attempt to describe the various degrees of density or consistence which inflammatory swelling presents, as resulting from the combined influence of the kind of matter effused, and that of the receiving structure. These alterations may be of two kinds: softening, chiefly in connection with acute inflammation, and induration, chiefly in consequence of chronic inflammation.

The diagnostic value of inflammatory swelling is not equal to that of redness. It is necessarily a later sign than redness, which always precedes effusion by an important and often appreciable period of time. Iritis is announced by injection of the ciliary arteries and a zone of redness around the iris, before the perilous effusion of lymph. Erysipelas spreads with a red blush before the disorganizing engorgement of the subcutaneous cellular tissue. Regarded as an exact sign, although some degree of swelling invariably follows inflammatory determination of blood, and although the nature of an obscure swelling is assured, if not by its physical properties, at least by puncture, and if necessary by further examination of the material of the swelling with the microscope; yet these guarantees of identity are the only unequivocal advantages of this sign. Unlike redness, it is no measure of the degree of inflammation. The most intense may produce a trivial swelling in an unyielding texture, and a trivial degree of inflammation will soon exhibit considerable swelling in a loose tissue.

Subject to these disqualifications, swelling is the more valuable sign, practically speaking, of inflammation. It can be discovered when the redness cannot be seen. In all superficial textures and parts, swelling can be readily detected. The skin, cellular texture, muscles, periosteum, bone, blood-vessels, and lymphatics, and the component tissues of the joints, severally present each a characteristic swelling when inflamed. Certain internal organs are also open to examination, *e.g.* the pelvic viscera, excepting the bladder. Thus, inflammatory enlargement of the prostate, or the uterus, and thickening of the rectum, can be felt, and possibly seen. Certain other organs are, indeed, beyond the reach of vision and the direct application of the hand, yet the ear can then detect effusion and swelling by means of percussion, as of the liver, gastro-intestinal canal, and spleen; and this may be aided by auscultation, as of the heart and lungs.

(4.) *Pain.*—Observe the influence of swelling. No sooner has the first contribution toward swelling been made by persistent distension of the vessels of the inflamed part, than pain, or at least exalted sensibility—tenderness—is induced by the blood's influence on the nerves of that part. The degree of pain from this cause will be regulated by both the elements which determine the amount of hyperæmia—that is to say, will be proportionate to the determination of blood, and the number of vessels in the part; but the number of sensory nerves

affected will further apportion the degree of pain. As swelling ensues from effusion, the same conditions which represent the degree of tension, will also measure the intensity of the pain. Thus a more solid, and therefore circumscribed effusion of coagulable lymph, underneath an unyielding texture, such as a fibrous membrane, *e.g.*, the fascia-lata, or a fluid similarly circumstanced, as an abscess in the substance of bone, are aggravating conditions inducing the most severe and unremitting pain; while a fluid, serous effusion into a loose texture such as the cellular tissue, say of the armpit, allows of a considerable accumulation without much pain, and will then be more tolerable. Pain is also attributed to structural change in the nerve-fibrils of the inflamed part.

The character as well as the degree of pain accompanying inflammation, is equally diversified. A burning pain in erysipelas, whence the popular name of this disease—St. Anthony's fire; a scalding pain in inflammation of the rectum, during evacuation of the fæces. Chronic rheumatism and lumbago are attended with the dull aching pain of inflamed fibrous and muscular tissues; gout, with a wrenching pain; abscess in bone, with an unremitting burrowing pain; inflammation of the dental periosteum, or periodontitis, with a throbbing pain. In other parts this character of pain is the known forerunner of suppuration. Parts endowed with but little sensibility in health, generally become acutely sensible when inflamed; as fibrous textures and bone, including the teeth; the intestinal canal in enteritis, the pleura and peritoneum respectively, when inflamed. Parenchymatous organs likewise acquire exalted sensibility, as manifested by the heavy, oppressive pain of pneumonia. Organs of special sense are for a time quickened by inflammation, and convey their own sensations but too keenly. The ear becomes too susceptible of sound, and iritis begets intolerance of light. The pain arising from inflammation may extend to parts distant, but continuous with the seat of origin; as from a whitlow, the pain passes up the finger and hand, thence perhaps up the forearm to the shoulder. Ophthalmic pain may involve the brow.

Reflected pains in distant parts are not uncommon symptoms of inflammation. Pain in the inner side of the knee may emanate from inflammation of the hip-joint; in the glans penis, from cystitis; in the testicle, from nephritis; under the right shoulder-blade, from hepatitis; and under the left scapula, from gastritis. Reflex motions are often excited in like manner: sneezing, by catarrh; coughing, by bronchitis and pneumonia; vomiting, by gastritis; and (reflex?) micturition, by cystitis.

The diagnostic value of pain is comparatively little. The pain of Inflammation being chiefly due to swelling, is scarcely an earlier sign. It is also the most inexact sign; pain may be absent in true inflammation, and present without; and is rather a measure of the kind of swelling than of the degree of inflammation. By itself, therefore, pain has little diagnostic importance.

(5.) The *function* of the organ or texture affected, undergoes certain changes, which constitute additional local symptoms of inflammation. They may be described in general terms, as exaltation of function, followed by its depression, and various perversions of function having an intermediate character. Thus, with inflammation of the brain; delirium, increased sensibility, and convulsions, are succeeded by stupor

and paralysis. Inflammation of the spinal cord presents similar symptoms; excepting, of course, any modifications of purely cerebral functions. With nephritis, the secretion of urine is first increased, then diminished; and so with regard to other secreting organs. In pneumonia, dyspnœa represents increased respiratory effort, but this is attended with imperfect aeration of the blood and the retention of hydro-carbonaceous matter. Accumulation of excrementitious matters in the blood is the most serious consequence of inflammation affecting any specially excreting organ; as the kidneys or skin.

From Inflammation, as a local morbid process, which I have designated Accelerated Nutrition of the part affected, we pass to its accompanying constitutional disorder, a febrile condition of the whole body.

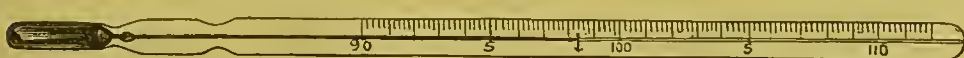
Constitutional Symptoms—Inflammatory Fever.—The phenomena of this fever are briefly these:—The heart's action is excited, the pulse becoming more forcible and frequent than usual, and in some cases less compressible, while the temperature rises, perhaps to 10° F. above the normal heat of the blood,—as determined by the *clinical* thermometer placed within the axilla or the mouth of the patient, for two or three minutes; the skin is dry and hot, alternating with chilliness or even shivering, the urine scanty and high-coloured, the tongue dry and furred, the bowels probably constipated, and the fæces dry and hard; thirst and inappetency, weakness with general nervous excitement,—restlessness, sleeplessness, or delirium, and hurried respiration, are also primary phenomena. Thus, the vascular, secretory, and nervous systems, are together engaged in a constitutional disorder —symptomatic of the local inflammation, and hence sometimes named *Symptomatic* Fever. When the nervous phenomena predominate, as delirious excitement, soon succeeded by exhaustion in broken-down constitutions, it has been named *Irritative* or *Nervous* Fever.

In a typical case of inflammatory fever,—as arising from compound fracture, without much hæmorrhage,—the patient, if otherwise sound and strong, exhibits the following symptoms, of which the *clinical* description given by Mr. Simon is true to life:—Before twenty-four hours have elapsed from the time of injury, the patient's general system begins to be thus affected. He feels hot, or alternatively very hot and chilly. His skin and lips and mouth are dry. He passes urine in less quantity, but of higher colour, than usual. His pulse is quickened. A sense of general disorder gains upon him. He becomes restless and intolerant of disturbance. Signs of drought increase with him. His urine becomes scantier and more coloured. His skin feels hotter to the surgeon's hand, and his pulse, whether full or hard, is quicker and stronger than before. He craves more and more for water. His face has a flushed, anxious look. He is thoroughly uncomfortable; feeling distressingly hot, but at intervals feeling touches of chilliness—sometimes even of such cold that he shivers with it. His sleep is troubled and unrefreshing; or, as night comes, he gets delirious. His tongue, besides being dry, is furred. If his bowels act (which commonly they are inapt to do without laxatives) the excretions are morbidly offensive. Gradually these symptoms give way: in proportion as the injured limb ceases to be tense, and passes into suppuration, the skin and mouth become moist again; the excretions lose their concentrated character; the hard pulse softens, and

the heart's action becomes quiet; the nervous system is no longer restless; the look of trouble passes from the countenance; and the patient can again take solid food.

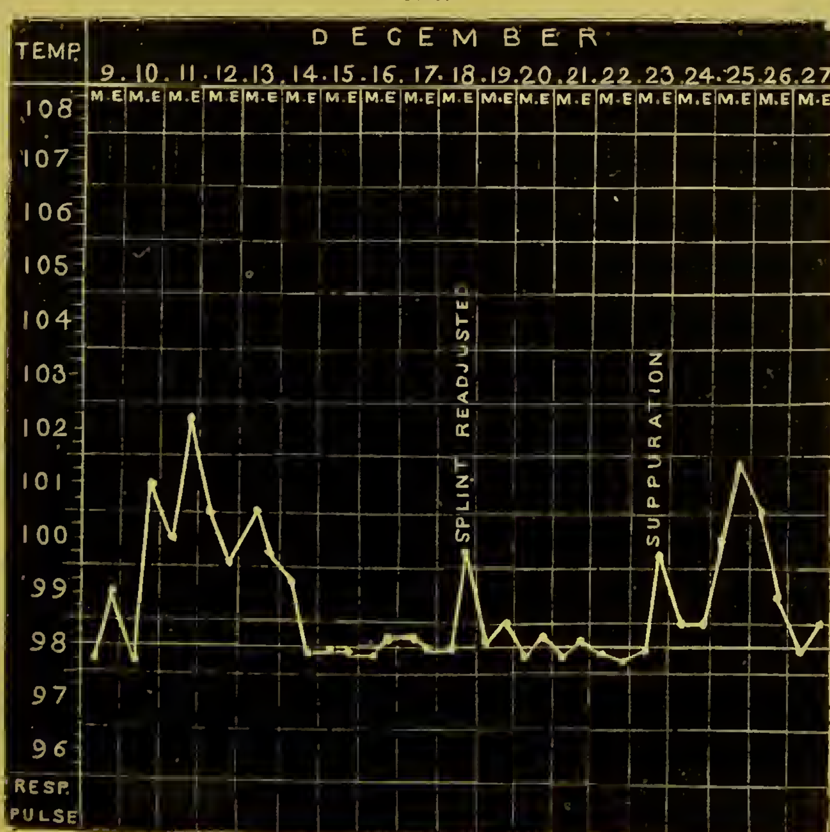
On *Temperature* in Disease, and the *Clinical Thermometer.*—In the process of Inflammation, the generation of *heat* may be termed a "product," just as the collection of lymph and white blood-cells, whether known as effusion or suppuration, are also products; accruing from those textural changes, involving the blood, which constitute a localized acceleration of nutrition, and which, in the increased production of heat, is still not inaptly designated Inflammation. But this increased production of heat in the part, becomes a more exact sign of the degree of inflammation, in proportion as any rise of temperature can be accurately *measured.* Then again, heat from the part, passing by successive increments into the blood in circulation, and thence raising the temperature of the whole body, is assuredly the most essential element of inflammatory fever. Yet here also, the value of this element, as a symptom of the degree or intensity of the fever, must be estimated by measurement. And in febrile conditions generally, not to mention most other forms of disease or injury, the temperature of the part or of the body has become a cardinal consideration.

Fig. 5.



Accordingly, in the clinical observation of inflammatory fever, for example, the question of temperature is now commonly determined by means of a delicate *thermometer* (Fig. 5), the use of which has entirely

Fig. 6.



superseded the far less exact appreciation of temperature by the sense of touch. For this method of observation, "Temperature Charts" have been constructed, to accurately record the temperature of a patient, at the two most significant periods, morning and evening, in the course of every twenty-four hours.

The state of the Respiration, and of the Pulse, each with regard to one important element—its frequency—is taken in conjunction with the Temperature.

The chart on page 51 (Fig. 6) represents the rise and fall of temperature daily, morning and evening, in a case of traumatic inflammatory fever, from compound fracture of the leg, under my care in the Hospital. After the fever-curve in this case, the influence of disturbing causes in producing an increase of temperature, is indicated also by the rise which occurred from readjustment of the splint, and when suppuration commenced.

For the record of observations in ordinary cases, a tabular view will perhaps suffice, as in the following form:—

*No.*________
in Register.

SURGEON ____________________

WARD ____________________

HOUSE SURGEON ____________________

DRESSER ____________________

Name						*Disease*					
DATE.	Hour.	Temp.	Pulse.	Resp.	REMARKS.	DATE.	Hour.	Temp.	Pulse.	Resp.	REMARKS.

But the *characters* of the Pulse afford no less faithful indications as to the state of the circulation; and here the invention of the Sphygmograph has at length supplied the most exact and intelligible evidence; for with this instrument the pulse wave writes, and records, its own testimony. Pulse-tracings must, however, be read and interpreted aright by the clinical observer. The use of the Sphygmograph in the investigation of disease is not generally understood; and as Dr. Mahomed has made this instrument and its applications the subject of special study, I am indebted to him for the following description.

On the *Pulse* in Disease, and the *Sphygmograph.*—"Various forms of Sphygmographs have been contrived, but none ever obtained recognition as an instrument likely to be of use in clinical medicine, till M. Marey produced his, which, with some modifications, is the one now in general use. His instrument was portable, could be applied without much difficulty, and yielded valuable information with regard to the circulation. The chief fault about this instrument is the inability to vary or gauge the amount of pressure applied to the artery,

and required to develop the pulse. Various methods have been suggested by which to regulate and measure pressure. That I have employed is at once accurate and simple. Fig. 7 is a drawing of this instrument, from which a general idea of it can be obtained, while Fig. 8 is a sectional diagram to illustrate the arrangement of the levers and the method of measuring pressure. The instrument consists of a brass framework attached to ivory bars, and is strapped upon the arm, which reposes on a double inclined pad or splint. The framework supports the spring which presses upon the pulse and the system of levers, by which the movements imparted to the spring by the pulse are magnified and conveyed to the writing lever, which inscribes them upon a slide, moved past its extremity by clockwork. To the framework also is attached a small brass box containing the clockwork; along a groove in the top of this box the slide, on which is stretched smoke paper, travels.

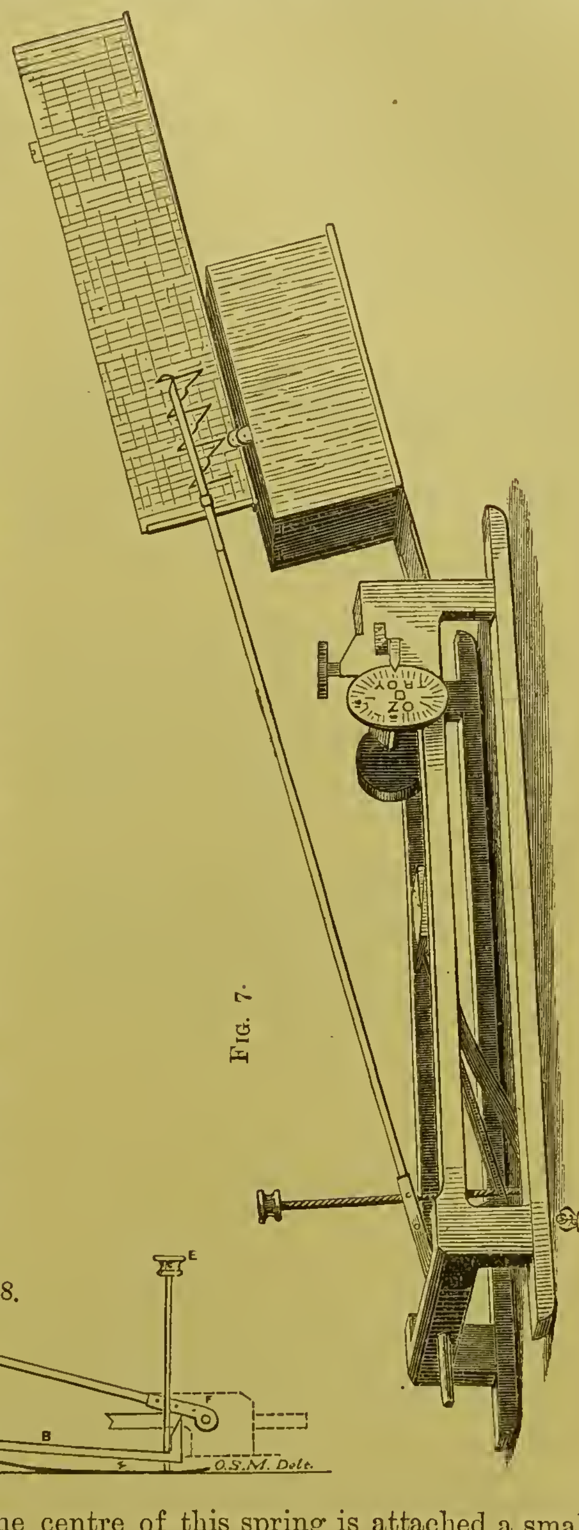


Fig. 7.

"The mainspring of the instrument A (Fig. 8) is attached to the framework by a hinge-joint H, and is free at the other end, which is

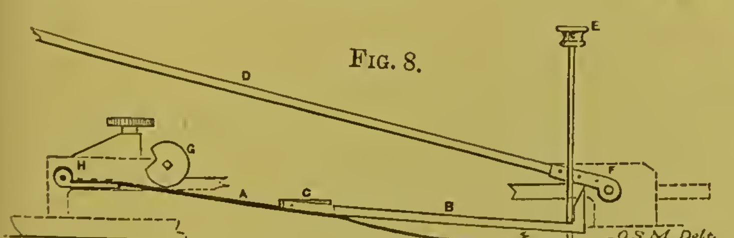


Fig. 8.

applied to the pulse. To the centre of this spring is attached a small block C, which is received between the bifurcated extremity of the short intermediate lever B, and which is attached to the block by a pin which forms its centre of movement. The free extremity of this lever is

turned upwards at a right angle, and ends in a sharp knife edge, upon which rests the long writing lever D. The centre of movement for this lever D is a pin, which passes through it and into the framework of the instrument at the point F. The screw E passes through the intermediate lever B, close to its free extremity, and rests upon the spring which presses upon the pulse. The movements of the pulse are imparted directly to the spring A, from the spring to the screw E, which rests upon it, by the screw to the intermediate lever B, and from the intermediate lever to the writing lever D.

"The writing lever D thus forms a lever of the third order, and though working at a mechanical disadvantage with regard to power, it gains in rapidity and extent of movement; the small movement imparted to it by the intermediate lever B, close to its fulcrum F, is greatly magnified by the very great proportional length of the whole lever, and the consequently much greater excursion of its free or writing extremity. By the screw E, the short intermediate lever is kept in contact with the writing lever, the distance between the writing lever and the spring varying with the depth to which the spring A presses into the soft parts, and therefore with the degree of pressure employed and the amount of fat in the subcutaneous tissue.

"The pressure of the spring upon the artery is varied by turning the thumb-screw at the side of the instrument, and thus causing the eccentric G to revolve above the spring A. The longer the radius of the eccentric at its point of contact with A, the greater the pressure upon the spring, and therefore upon the artery. The amount of this pressure is indicated on a dial plate, seen at the side of the instrument, and measured in ounces of Troy weight. The pressure employed to obtain a perfect tracing should always be recorded, and the pressure required to completely compress the pulse and arrest the movements of the lever may also be noted.

"It is unnecessary to detail at length the method of applying the instrument; suffice it to say that the arm should be placed on a double inclined pad, the angle of which should be about 135°, the instrument strapped on to it, care being taken to apply the ivory pad at the extremity of the spring over the centre of the radial artery, where it lies on the inner side of the styloid process, and is crossing the anterior ligament of the wrist-joint. The proper pressure to employ is that with which the greatest height of upstroke can be obtained. The upstroke should be uninterrupted and the apex sharp, forming an acute angle with the downstroke, any variation from this being due (except in very rare instances) to an imperfect application of the instrument. The paper on which the tracing is taken should be double enamelled, and enamelled on both sides. It is most easily smoked by burning a small lump of camphor, the size of a pea. After the tracing has been obtained, it may be varnished by passing the slip of paper through a simple spirit varnish, made by dissolving one ounce of gum benzoin, or Burgundy pitch, in eight ounces of methylated spirit.*

"The tracing obtained by this instrument from a normal pulse reveals the fact that the pulse felt by the finger is not merely a simple movement of expansion and contraction of the artery, produced by

* The instrument and all necessary appliances can be obtained of Messrs. Krohne and Sesemann, 8, Duke Street, Manchester Square. Price seven guineas.

each contraction of the heart, but is composed of three factors, the part played by each of these varying under different circumstances of disease. They do not depend, however, for their existence on any peculiar or complicated condition of the circulation in the human body, but merely on the ordinary laws of hydrodynamics, and are invariably produced when fluid is pumped, in an intermitting stream, forcibly and suddenly through an elastic tube. The development of each varies with conditions which can be experimentally ascertained and varied at will, so that a pulse of any character can be obtained by regulating the conditions accordingly.

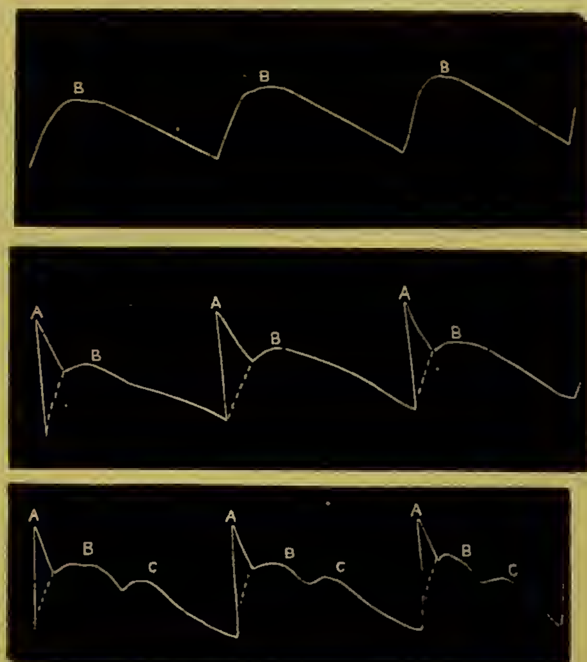
"The simplest pulsatile movement that can be conceived in an elastic tube is the mere passage of a wave of fluid through it, causing more

Fig. 9.—Formation of Pulse Wave.

(*a.*) Tidal wave B.

(*b.*) Tidal wave B + percussion wave A.

(*c.*) Tidal wave B + percussion wave A + dicrotic wave C.



or less sudden expansion, and a gradual collapse of the tube, as it passes through it; such a wave is the foundation of the pulse, and has been called the "Tidal" wave. (Fig. 9*a*.) If the impulse imparted to the fluid is more sudden, an element of percussion or shock will be introduced (Fig. 9*b*), giving an abrupt and vertical upstroke, from the jerking up of the lever by the sudden expansion of the artery. Owing to its acquired velocity, this movement of the lever is rather greater than the corresponding movement in the arterial wall which produced it, and on reaching its highest point, it falls suddenly by its own weight, till it is again caught and perhaps slightly raised by the tidal wave A, which is now only reaching its maximum of distension.

"The third element is that of elastic recoil, and is produced by the contraction of the elastic wall of the vessel or tube, which occurs immediately on the termination of contraction or systole; this is called the 'Dicrotic' wave. (Fig. 9*c*.) The elastic wall of the vessel is overdistended during systole, owing to the acquired velocity of the blood, which is considerable on account of its great inertia and the force of the ventricular contraction; and immediately systole ends and the

acquired velocity is exhausted, the over-distended elastic wall springs back and originates a new wave, which is prevented passing backwards by the closure of the aortic valves which it produces, and therefore passes forwards, imparting a fresh impulse or wave to the blood-stream, called the dicrotic wave, or diastolic expansion. A small secondary wave of somewhat similar production to the last is occasionally seen in the remainder of the downstroke, being apparently a slight oscillation, before an equilibrium is attained between the blood-pressure within the tube and the elastic pressure of its walls.

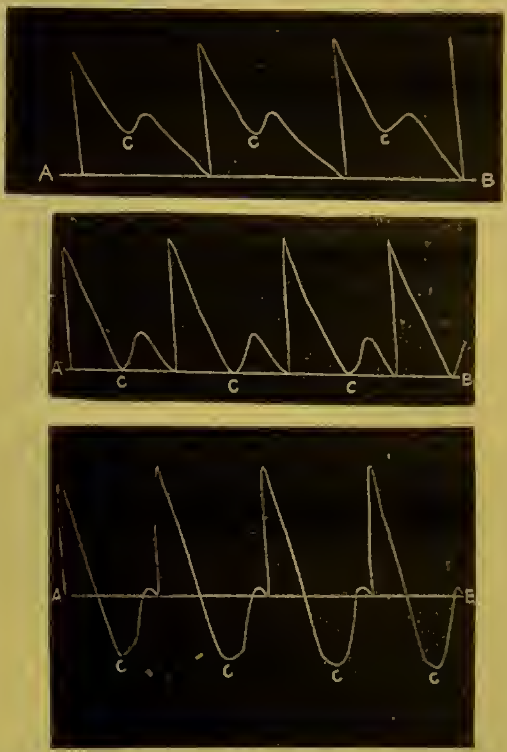
"Various degrees of dicrotism occur, to which terms have been applied indicating the relation of what is known as the Aortic notch to the respiratory line of the tracing. The *Aortic* notch, sometimes called the *dicrotic* notch, is the notch immediately preceding the dicrotic wave, or diastolic expansion. (Fig. 10, c.) It is so called be-

Fig. 10.—Degrees of Dicrotism.

(*a.*) Dicrotic.

(*b.*) Fully dicrotic.

(*c.*) Hyperdicrotic.

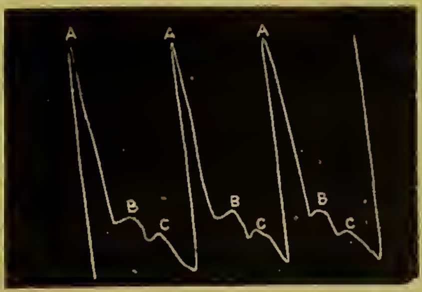


cause it is coincident with the closure of the aortic valves, and indicates the termination of systole; the portion of the pulse wave preceding it coincides with systole, that following it with diastole. The *Respiratory* or *base* line of the tracing is the line drawn through the lowest points of the upstrokes. (Fig. 10, A B.) It should be straight in a normal tracing, but it varies if the amount of blood in the vessels, or arterial tension, varies. Thus, if during the tracing a deep inspiration be made, the blood tension is reduced, owing to the suction action of the thorax, and there is a fall in the respiratory line, while by complete expiration the tension is increased, and an elevation occurs in the respiratory line. So in some cases of disease, when there is severe dyspnœa, and dilatation of the right side of the heart, there is a constant variation in the respiratory line with each movement of respiration; it is then called '*undulating*.'

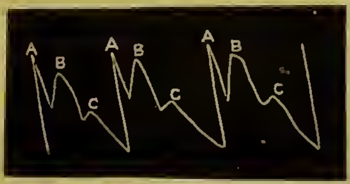
"To return to the degrees of dierotism. If the dierotie notch C is well marked, but its lowest point does not reach the respiratory line, the pulse is called 'dicrotic,' or sometimes *hypodicrotic*, but this term tends to confusion (Fig. 10*a*); if the notch C reaches to the level of the respiratory line A B, the pulse is called *fully dicrotic* (Fig. 10*b*); lastly, if the noteh C sinks below the level of the line A B, it is then called '*hyperdicrotic*' (Fig. 10*c*).

FIG. 11.—Extreme Developments of each Wave.

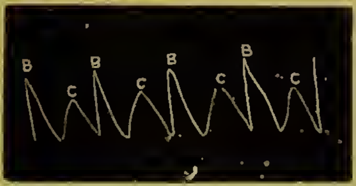
(*a*.) Exaggerated percussion.



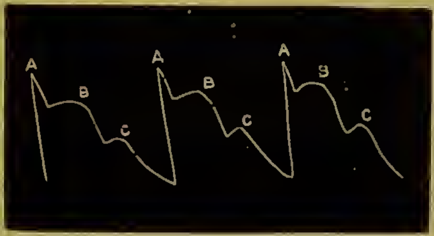
(*b*.) Ditto.



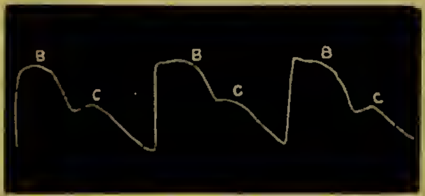
(*c*.) Exaggerated dicrotic.



(*d*.) Exaggerated tidal.



(*e*.) Ditto.



A = Percussion. B = Tidal. C = Dicrotic.

"Briefly, then, the Pereussion wave is due to shock or sudden impulse, and is produeed by sudden and forcible eontraction of the heart. It may oecur in a very exaggerated degree and form the most striking feature in the tracing (Fig. 11*a*), owing to an excited action of the heart; or it may be transmitted much more rapidly than the tidal wave, so that the two beeome distinetly separated

from each other (Fig. 11*b*). This occurs in conditions of high tension, with excited and forcible action of the heart, as in early stages of Bright's disease.

THE PERCUSSION WAVE IS

Increased by	*Diminished by*
1. Forcible contraction.	1. Feeble contraction.
2. Sudden contraction.	2. Gradual contraction.
3. Large volume of blood.	3. Small volume of blood.
4. Fulness of vessel.	4. Emptiness of vessel.

"The Tidal wave is the true pulse wave, and indicates the passage of a volume of blood through the arteries, pumped into them by each contraction of the heart. It resembles the passage of the tidal wave or 'bore' up a river; hence its name. It is transmitted more slowly than the percussion wave, or rather attains its maximum intensity more gradually; hence their separation in the tracing. Though they usually commence to distend the artery together, the percussion wave necessarily attains its maximum intensity instantaneously, it being only a shock, while the tidal wave does so more gradually. (Fig. 11*a*.) Sometimes a considerable interval elapses between them. (Fig. 11*b*.) Frequently they are inseparable, the percussion wave not existing, or else being merged into the tidal. (Fig. 11*c* and *e*.)

THE TIDAL WAVE IS

Increased by	*Diminished by*
1. Slow and prolonged contraction.	1. Quick and short contraction.
2. Large volume of blood.	2. Small volume of blood.
3. Emptiness of vessels.	3. Fulness of vessels.
4. Diminished outflow, or slow capillary circulation.	4. Increased outflow, or rapid capillary circulation.

"The Dicrotic wave is the wave of elastic recoil, due to the contraction of the aorta. It occurs during the diastole of the heart. It may reach almost as high as the tidal and percussion. (Fig. 11*c*.)

THE DICROTIC WAVE IS

Increased by	*Diminished by*
1. Sudden contraction.	1. Gradual contraction.
2. Emptiness of vessels.	2. Fulness of vessels.
3. Increased outflow, or rapid capillary circulation.	3. Diminished outflow, or slow capillary circulation.
4. Elasticity of aorta.	4. Rigidity of aorta.
5. Relaxation of muscular coat.	5. Contraction of muscular coat.

"The Sphygmograph will indicate and explain the meaning of all the terms usually employed in describing the pulse. Thus, the pulse may be 'hard' or 'soft;' that is, require much or little pressure. It may be 'sudden' or 'gradual,' namely, having a well-marked percussion wave or none at all; 'large' or 'small,' according to the size of the tidal wave and height of upstroke, which will depend on the volume of blood sent into the vessels by each systole, on the emptiness or fulness of the vessels during diastole, and on the contraction or relaxation of the muscular coat of the arteries. Should they be contracted, the terms 'wiry' or 'contracted' are applied to the pulse. The pulse is called 'flickering' when the systoles are feeble and unequal, the tidal waves being therefore unequal in volume and perhaps in rhythm; or 'undulating' from an undulation in the respiratory line; 'dicrotic,' if the dicrotic wave can be felt. Irregularities in rhythm

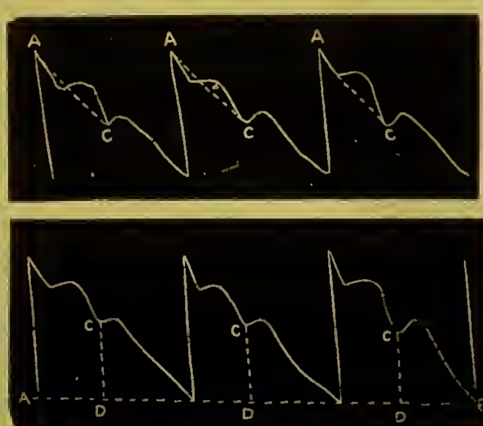
are also particularly well shown, and their cause, whether purely cardiac or dependent to some extent on the respiratory movements, indicated. There is one character of the pulse, however, which is perhaps the most important of all to recognize, and which the Sphygmograph does not indicate, namely, that of 'persistence.' By this is meant the ability to feel the artery during the diastolic period, owing to its prolonged distension and overfulness, due to contracted arterioles or impeded capillary circulation, whichever may prove to be the true cause of what is known as 'high tension.' Although this particular character is not shown by the Sphygmograph, and can only be felt by the finger, nevertheless others which are always associated with it, are most perfectly indicated by the instrument, and comprise the signs of 'high tension.' It is as a measure of 'arterial tension' that the Sphygmograph is perhaps of the greatest value, and a few words on the indications of the degree of tension existing are necessary.

"By the term 'high tension' a condition is meant in which the arteries are fuller than natural. It produces increased resistance to the heart's contraction, and increased pressure on the arterial walls. If such a condition be chronic, it produces hypertrophy of the left ventricle and thickening of the heart, as in chronic Bright's disease, and is also the immediate cause of atheroma, aneurism, apoplexy, albuminuria, and other conditions. The most constant indication of this condition is prolongation, or undue sustension of the tidal wave. This can be

Fig. 12.—To gauge High Tension.

(*a*.) Line from apex of upstroke to bottom of aortic notch.

(*b*.) Line from bottom of notch to base line.



gauged as follows:—Let a line be drawn from the summit of the often upstroke to the bottom of the aortic notch (Fig. 12*a*, A C); if any part of the tidal wave rises above this line, forming a curve with its convexity upwards, the tidal wave may be said to be unduly sustained, and the arterial tension to be high. The next important sign of high tension is the height of the line drawn from the bottom of the aortic notch to the base line. (Fig. 12*b*, C D.) The longer the line, the higher the arterial tension, and *vice versâ*.

"In high tension the percussion wave is usually well marked, and separated from the tidal wave. (Fig. 11*b*.) Sometimes it is absent, from failing power and feeble contraction of the heart. (Fig. 11*c*.) High tension may exist with the muscular coat of the arteries contracted or relaxed; the upstroke may therefore be short or high. It usually requires considerable pressure to develop the pulse, but not

invariably; this depends upon the strength of the heart and the force of its contractions."

"The other extreme of tension is gauged by the dicrotic wave, the size to which it is developed, the shortness of the line C D (Fig. 12*b*), or its entire absence; the pulse being fully or hyperdicrotic. (Fig. 10*b*, *c*.) In addition to this, the percussion wave is generally absent, and the collapse of the tidal wave sudden, the angle formed by the upstroke and downstroke being very acute. This sudden collapse is due to the emptying of the artery being sudden and not gradual.

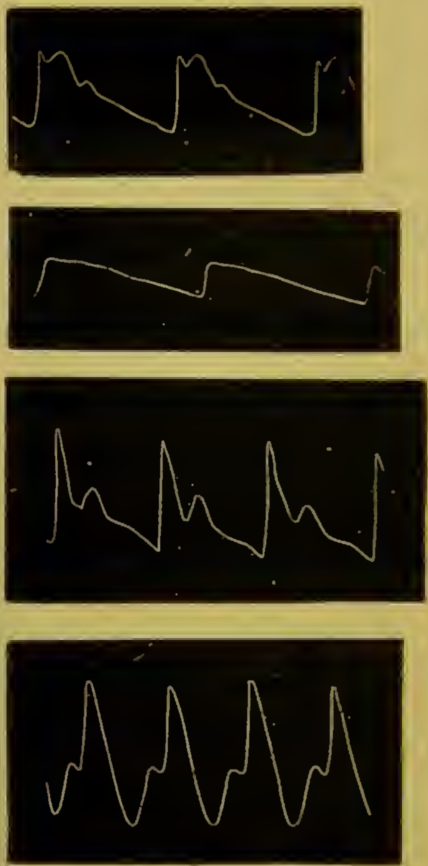
FIG. 13.—Variations in Arterial Tension.

(*a*.) *High.* Chronic Bright's disease. Pr. 5 oz.

(*b*.) *Medium.* Normal. Pr. 3 oz.

(*c*.) *Low.* Normal. Pr. 3 oz.

(*d*.) *Very low.* Typhus. Pr. 1 oz.

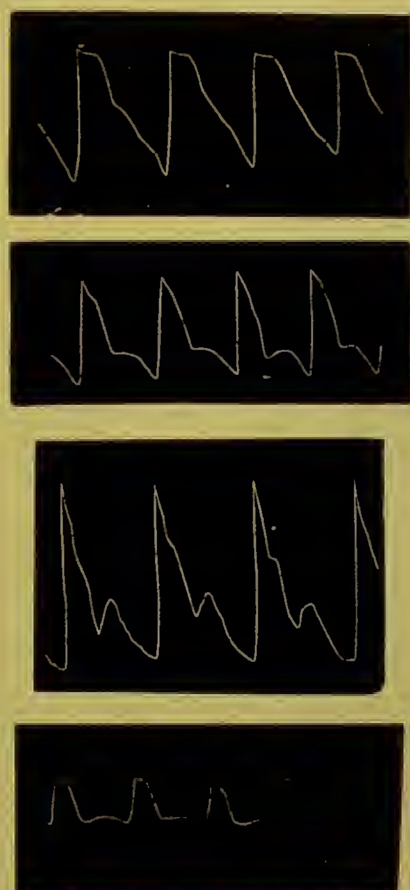


"The degrees of tension which are commonly met with are very various; four types may be given:—The extreme high tension of Bright's disease (Fig. 13*a*); the medium or normal tension of a healthy pulse of good tone (Fig. 13*b*); the low tension often found in healthy persons, with bad tone and relaxed vessels (Fig. 13*c*); the extremely low tension of the hyperdicrotic pulse of fever (Fig. 13*d*). To these might be added the pulse of empty arteries, as in free aortic regurgitation.

"From this consideration of the pulse in general, let us return to that of Inflammatory fever, which is of considerable interest, and affords valuable assistance in the prognosis and treatment of the case. In simple inflammatory fever of the sthenic type, although the temperature may be high, the pulse is one of rather high tension; this is also the case with erysipelas in some cases, and these are generally of a mild

nature. In inflammatory fever of an asthenic type, and occurring in debilitated subjects, the pulse may be one of low tension and considerably dicrotic; this is especially the case if there be any tendency to pyæmia, when the pulse is almost invariably of low tension and very dicrotic. So, in low forms of asthenic erysipelas, the pulse is often hyperdicrotic, and these cases especially require free stimulation. With pulses of high tension in inflammatory fever, depletion and antiphlogistic treatment may almost invariably be employed; it is the 'hard' pulse which the old practitioners regarded as the infallible indication for bleeding.

Fig. 14.—High Tension Pulses in Traumatic Fever.



(*a.*) Second day after ovariotomy. I. 100. Pr. 2 oz.

(*b.*) Third day after excision of breast. Pr. 3 oz.

(*c.*) Scalp wound. Pr. 2 oz.

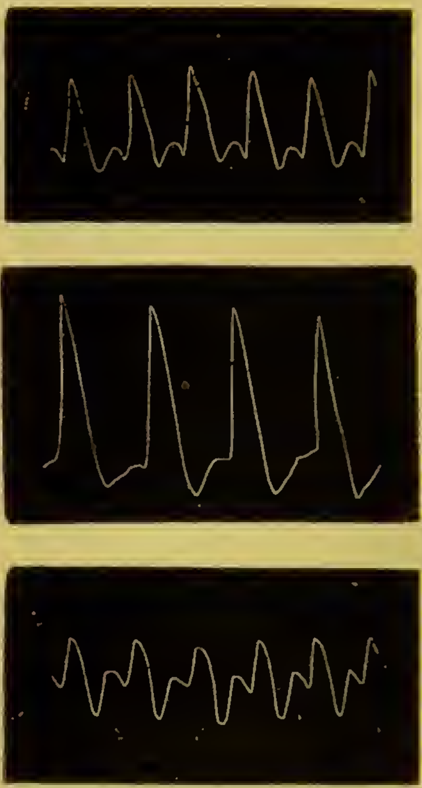
(*d.*) Severe contusions and fractured thigh. T. 103·8. Death next day. Pr. 2 oz.

"If, however, the pulse in inflammatory fever be one of low tension, stimulants and a generous regimen are required. Fear also may be entertained of pyæmic infection; absorption probably takes place more readily in this condition than in high tension. Further indications may be afforded by the amount of pressure required to develop the tracing, and the presence or absence of well-marked percussion showing the strength of the heart and its mode of contraction; a sloping upstroke and a rounded top being the infallible indications of a failing heart.

"There is no rule as to the nature of the pulse in inflammatory fever, erysipelas, or pyæmia; either high or low tension may occur in either of these conditions. Roughly speaking, however, it may be said that

high tension is most likely to be met with in inflammatory fever, and low tension in pyæmia. The tracings in Fig. 14 give types of degrees of high tension occurring in inflammatory fever in different individuals, and from various causes; while those in Fig. 15 give

Fig. 15.—Low Tension Pulses in Pyæmia.



(*a*.) Pyæmia. Pr. 2 oz.

(*b*.) Puerperal pyæmia. Pr. 3 oz.

(*c*.) Pyæmia after amputation of thigh. Death two days afterwards. T. 103·5. Pr. 2 oz.

types of low tension occurring in pyæmia. The last tracing in Fig. 14 gives the form of pulse immediately preceding death, when the tension has been high throughout, namely, a short and rather sloping upstroke, with a slight rounding of the apex, and a want of sharpness or rounding off of the angles about the tracing; while the last tracing in Fig. 15 exhibits the form of pulse preceding death, the tension having been low throughout the illness. In this case the pulse is hyperdicrotic, while the upstroke is also short and a little sloping."

The *Urine*, in Health and *Disease*.—The urine in disease undergoes alterations which can be estimated only by observing the characters and composition of the urine in health, as the representative and exponent of blood-conditions in health. The student, therefore, will do well to start with this physiological knowledge before proceeding to the description of *febrile* urine.

HEALTHY URINE.

Physical Characters.—A fluid, clear, of a bright amber colour, peculiar aromatic odour, and specific gravity or weight, varying from 1·015 to 1·030, the average being 1·020, when *cold*. The quantity secreted varies from 30 to 80 fluid ounces in twenty-four hours, the

average being about 52 ounces. Slightly acid, except after food, when it becomes neutral or alkaline, during digestion in the stomach—chymification.

Chemical Composition or Constituents—qualitative and quantitative.—Mean or average in twenty-four hours, for the adult male :—

		Grains.
	Urea	512·40
	Uric acid	8·56
	Phosphoric acid	48·80
	Oxalic acid	1·42
	Sulphuric acid	31·11
	Hippuric acid	34·50
	Chlorine	126·76
	Extractives, *e.g.* creatine and creatinine, and colouring matters	154·00
	Soda	125·37
	Potash	58·21
	Ammonia	8·58
	Lime	3·55
	Magnesia	3·09
	Iron	undetermined
	Mucus (adventitious)	7·00
Total	Solids	1123 35 Grains weight.
	Water	52¼ Ounces measure.

In estimating the quantity of any urinary constituent excreted in twenty-four hours, the weight of the body and activity of the functions must both be compared therewith. Thus the excretion of only 150 grains of urea, in a person whose weight is 80 lbs., would be a healthy proportion ; but if the weight be 170 lbs., that quantity would be very disproportionate, and indicate a diseased condition of serious or fatal consequence.

The physiological origin of the urinary constituents is represented in the following tabular view, taken from Dr. Golding Bird's well-known work, edited by Dr. Birkett :—

1. *Organic Products.*

1st. Ingredients characteristic of the secretion produced by the destructive assimilation of tissues, and separated from the blood by the kidneys.	Urea, uric acid, creatine, creatinine, colouring and odorous principles.
2nd. Ingredients developed principally from the food during the process of assimilation.	In addition to the above, hippuric acid, lactic acid ; accidental constituents.

2. *Inorganic Products.*

3rd. Saline combinations separated from the blood, and derived from the food.	Sulphates, phosphates, chloride of sodium, and all soluble salts taken with the food, and often undergoing decomposition in the system.
4th. Saline combinations chiefly generated during the process of destructive assimilation.	Sulphates. Phosphates.

3. *Ingredients derived from the Urinary Passages.*

5th. Mucus of the bladder.
6th. *Débris* of epithelium.
7th. Phosphate of lime.

Febrile urine exhibits physical characters and chemical peculiarities of diagnostic importance. At first, it has a deep red colour, strong urinous odour, super-acid reaction, high specific gravity; and the quantity secreted in a given time is diminished. These alterations are chiefly owing to a reduced proportion of water, rather than of solid constituents in the urine, which has thus become concentrated. But the inorganic salts, especially the chloride of sodium, are diminished, both absolutely and relatively; while uric acid and the urates are increased. Even when urates are not deposited, there is always an excess of uric acid. Urea is increased in some cases, and probably diminished in others. The greatest quantity present would appear to be in meningitis, and an excess is found during exudation; but urea is diminished during resorption, in pneumonia, pleurisy, and in acute rheumatism, especially if accompanied with endocarditis. Extractive matter is generally increased, and lactic acid is often present. Occasionally, a small quantity of albumen is found, but only for a short time. As inflammatory fever declines, the urine deposits a lateritious brick-dust, coloured sediment, more or less abundant, consisting of urate of ammonia.

The quantity of *sweat* is much diminished during inflammatory fever, but its chemical composition at that time is not well understood. Ulcers, also, which have been discharging freely become dry. The flow of *saliva* is less free, and the tongue furred. This appearance arises from a material of whitish yellow or brown colour and firm consistence, overlaying the posterior and middle portion of the tongue on its upper aspect, and adhering closely. It cannot be removed altogether by scraping, but as the fever declines it is shed spontaneously. If, says Dr. Thomson, this fur arose from the nature of the saliva secreted, then, instead of being found only on the upper, middle, and posterior parts of the tongue, we should find it incrusting the whole internal surface of the mouth. It is probably secreted from the papillæ to which it adheres. A similar appearance arises from irritation of the stomach, without any fever at all. Discrimination, therefore, is necessary, by considering whether other symptoms concur.

Blood.—The blood undergoes certain very important alterations in inflammation, and which are of two kinds,—namely, in respect to its vital properties, and therefore as affecting its coagulability and coagulation; and in respect to its chemical composition. The resultant blood-condition affords another and very significant symptom of inflammatory fever, and which can be readily ascertained, when necessary, by drawing off a sample, say a few ounces, from the general mass of blood, as supplied by venesection.

(*a.*) The altered *vital* properties of the blood comprise—an increased tendency to coagulation, and to the separation and contraction of the fibrin in a free state. The phenomena known as the *buffy coat* and *sizy* blood are thus produced. These appearances can be understood by comparing the changes which take place, as observed in the coagulation of *healthy* blood.

Let a pint of fresh-drawn blood be exposed in a shallow basin; immediately a vapour, having a faint odour, arises, which (*halitus*) was first noticed by Haller. In about four minutes a pellicle appears at the edge of the vessel, soon extending over the surface of the blood and down the sides of the vessel. It pervades the whole mass in about eight

or nine minutes. The fluid blood is thus converted into a jelly. But in a variable period, from seventeen to twenty minutes, or much later, this jelly begins to shrink away from the sides of the basin, and the colourless, transparent serum exudes—a process which, continuing for several hours, or even days, at length leaves a blood-red clot, floating about in limpid serum. And what is this clot? The *fibrin* of the liquor sanguinis, which has spontaneously solidified into fine homogeneous filaments, interwoven like felt, and which has caught and involved the red corpuscles. They also have spontaneously aggregated, their disc-shaped surfaces cohering side by side, and forming *rouleaux*, like piles of money, which connected themselves into an irregular network; the shrinking of this fabric, intertwined with that of the fibrin, expressed the serum, and thus aided the solidification of the clot. Two constituents, therefore—the fibrin and red discs—together spontaneously aggregate to form the clot, which consists of woven filaments involving the net of red discs. The expressed serum is structureless. The pale or colourless corpuscles are irregularly distributed throughout the clot and serum.

These changes are represented in the following table:—

Fluid Blood.	Liquor Sanguinis.	Serum.		Coagulated Blood.
		Fibrin.	Clot.	
	Corpuscles.			

If the blood, freshly drawn as we have supposed, be *inflammatory*, its coagulation then presents a clot, the upper portion of which is pure fibrin, of a tawny-yellow colour, and known as the *buffy coat*. This, therefore, consists of a portion of fibrin, which has coagulated apart from the mesh formed of red discs. And what is the immediate cause of this kind of clot? Obviously, that the red discs separated and subsided from the liquor sanguinis before the fibrin began to coagulate. How does such isolation arise? Possibly in either of two ways, or by a concurrence of both. The fibrin may coagulate so slowly as to allow time for the blood-discs to separate and subside. But Dr. Stokes watched the coagulation of inflammatory blood in twenty-seven cases. In fifteen of them the buffy coat formed; in the remaining twelve it did not. In four of these twelve samples of ordinary coagulation, it began only at the end of eight minutes after venesection, and in other three of this series not until after twenty to forty minutes had elapsed, making a range between the two extremes of from eight to forty minutes. This delay of coagulation gave ample opportunity for the red discs to escape from the fibrin during its solidification; yet they did not subside, and the usual red clot formed. On the other hand, in twelve of the fifteen samples of buff-forming coagulation, the yellow clot of pure fibrin formed in only five minutes, and in the remaining three it was delayed only to ten minutes; so that, during this comparatively short period of five or ten minutes, the red particles had separated and settled down, leaving the buff-coloured fibrin free and floating. Slow coagulation, therefore, does not explain the production of the buffy coat.

The only other active element in coagulating blood is the mesh-forming discs; and how do they behave in freshly drawn inflammatory blood? They individually possess undue power of aggregating (H.

Nasse), and the net thus wrought has also undue power of contracting (W. Jones), whereby the serum is more effectually expressed from its meshes. This fabric, therefore—the component particles of which have individually greater specific gravity than the serum—has now even greater weight, bulk for bulk, and being formed earlier than usual, subsides in the serum before the fibrin has fairly solidified, or perhaps before this more essential element of the clot has begun to coagulate. John Hunter seems to have anticipated this view of buffy blood, and Schroeder Van der Kolk, with other observers, has corroborated it.

Combining all these observations—formation of the buffy coat seems to imply an increased separation and contraction of fibrin in a free state, rather than its increased power of separation and contraction, and that the blood-discs are the initiative and active element in the process of buff-forming coagulation.

Slow coagulation of the fibrin will, however, favour this result, by allowing more time for the gregarious blood-discs to flock together and exercise their function as a contracting mesh. If, therefore, the blood be artificially preserved in a fluid state, by adding serum to above its normal proportion, thereby delaying coagulation, the red discs aggregate and subside, and the buffy coat is thus presented.

Probably both the causes I have mentioned concur to produce this result, and that as they prevail more or less during the act of coagulation, so is the buffy coat of pure fibrin more or less completely established.

The earliest intimation that blood is about to undergo this kind of coagulation, is the appearance of a violet tint, not unlike the bloom of black Hamburg grapes, on the surface of the exposed blood. This appearance was, I conceive, noticed by Hunter, and regarded by him as due to the red particles shining through a thin layer of buff-coloured lymph, just as blood in the veins gives a similar tint when viewed through the skin. The tint will therefore vary as the layer of fibrin becomes thicker. Coagulation proceeding, if the mesh of red particles separate and subside from the fibrin, but yet slowly and incompletely, and if the free fibrin but imperfectly solidifies and contracts, then a loose *sizy* clot is produced, resembling a solution of isinglass, attached to the sides of the vessel, and scarcely trembling when shaken. If, again, the separation and contraction of pure fibrin be more complete, a flat, yellow buff-coloured cake is produced, swimming in serum; but the under portion of this clot is red as usual by admixture of the red discs. If, again, the separation and contraction of fibrin be still more complete, the fully formed, solid, and buff-coloured clot is presented, withdrawn from the sides of the vessel, and probably concave or *cupped* on its upper surface; the lower portion of this clot having formed more slowly, has contracted more strongly, and drawn down the central part of its upper aspect. The blood, or rather the clot, is buffed *and* cupped. Even in this case the red particles and fibrin do not completely separate. In thirty samples of buffed blood, carefully inspected by Dr. Richardson,* he never failed to find red discs in the lower portion of the clot, and in many instances this red lower portion had the consistence of ordinary coagulum.

The *diagnostic value* of these appearances is not absolute. In-

* "The Cause of the Coagulation of the Blood," p. 335.

variably present with inflammation, they are also present in other conditions affecting the blood. Coagulation exhibits the buffy coat notably in pregnancy, and other conditions attended with an excess of fibrin in the blood; and both the buffed and cupped appearance may proceed from slow coagulation, without any change in the constitution of the blood itself, as when this fluid is drawn quickly, in a full stream, and received into a narrow deep vessel. Conversely, exposure, as by a trickling stream, into a shallow vessel, hastens coagulation, and thus prevents these results.

(*b.*) Besides these deviations in the process and product of healthy coagulation, inflammatory blood is found to have undergone certain alterations of *chemical composition*. Its constituents, no less than their properties and endowments, are perverted. Becquerel and Rodier enumerate the following alterations in the blood of acute phlegmasiæ:—

1. An increased proportion of fibrin.
2. A decrease of globules.
3. A decrease of albumen of the serum.
4. An increase of fatty matters.
5. A decrease of soda and soluble alkaline salts.

In point of practical interest, the importance of all these chemical changes appears to concentrate in the influence they exercise on the separation of the fibrin, and its coagulation in a free state.

Alkaline salts in excess are well known to retard coagulation, and a decrease of the soda and soluble alkaline salts will have the opposite effect. Less time than usual is then allowed for the blood-discs to subside, and so far the formation of the buffy coat is not promoted.

An increased proportion of fatty matter will probably favour the early separation of pure fibrin, by inducing it to rise with such matter to the surface of the blood drawn, and leave the red discs below.

A decrease of the albumen of the serum will have a similar effect, by directly diminishing the specific gravity of this fluid, so that the blood-discs sink more readily. The mean specific gravity of the serum in the phlegmasiæ generally, is estimated by Becquerel and Rodier at 1027·0; and although, according to Nasse, that is about the average in health, yet the specific gravity of serum in inflammations frequently declines below the mean of 1027. And this is due to the proportion of albumen being reduced below the healthy average of 80 parts in 1000, to 73·35, and even as low as to 64·84. It was formerly stated by Gendrin that the albumen rose to about twice its proportion above the standard of health. The decrease noted is in a direct ratio to the increased proportion of fibrin.

So also the blood-discs decrease in quantity proportionately to the increase of fibrin (Simon), and this reduction will facilitate their complete separation—the more so, since, by undue aggregation of the discs, their combined specific gravity preponderates even more than they do individually.

Lastly, the increased proportion of fibrin above the average of two to two and a half parts in 1000 of blood, contrasting as it does with the reduced proportion of blood-discs, is the culminating point in favour of a clot being formed of pure fibrin; and this increase, and corresponding formation of the buffy coat, was noticed by Andral and

Gavarret to rise as high as ten parts in 1000 of blood drawn, in acute articular rheumatism, and in pneumonia.

The source of this additional proportion of fibrin is doubtful.

Simon suggests that the blood-discs are transformed into fibrin, and in conformity with an acknowledged physical law, that as textures waste in proportion to their functional activity, so therefore the blood-discs disintegrate more abundantly in inflammation—owing to their function as bearers of oxygen to the various textures being overtaxed, in the more frequent transmission of these discs through the lungs, by acceleration of the blood's circulation. The flotilla of oxygen-laden cells perishes from overpressed service, and their wrecks are converted into fibrin. Simon's statement that the discs decrease in quantity proportionately to the increase of fibrin, harmonizes with his theory; but, against it, Becquerel and Rodier urge that this destructive change ought to take place whenever the circulation is accelerated, and therefore whenever fever exists. Yet an increased proportion of fibrin is not found in other fevers accompanied with an accelerated circulation.

Is the excessive fibrin transformed albumen? Probably similarity of composition allows of such transformation; and certainly, as the albumen diminishes in quantity, so does the proportion of fibrin increase.

Of this metamorphosis we know neither the cause nor the mechanism, observe Becquerel and Rodier.

Summarily, the coagulation of inflammatory blood—when drawn and fresh—amounts generally to this: the blood-discs, having an undue tendency to aggregate, and the net they form an undue power of contracting, more speedily sink in serum, normally of less specific gravity than the discs individually, of still less than the shrunken net of discs; and that this separation of the discs (before coagulation of the fibrin) is facilitated by their reduced number, and by diminished specific gravity of the serum itself. The fibrin, itself increased in quantity, then coagulates free of blood-discs, at least in its upper portion, and rises to the surface of the serum, its ascent being probably aided by admixture with the free and floating fat.

Pathology of Inflammatory Fever.—The alterations of the *blood*, in connection with inflammation, proceed apparently from the persistent local determination of blood, coupled with the increased productiveness and destruction of the textures. The increased proportion of fibrin, and the increased tendency to coagulation and to separation and contraction of the fibrin in a free state forming the buffy coat, are both commonly proportionate to the extent of the inflammation, and its duration in an active state. Under similar circumstances of nutrition, the same blood-conditions are induced in a greater or less degree; as during pregnancy, when the uterus is growing; and the buffed appearance of the blood is readily induced by inflammation in fast-growing children, in whom also the plastic products are then unusually copious. Other writers believe—and Mr. Simon ranks himself most unreservedly among them—"that the blood yields more fibrin, not in proportion as it is ripe and perfect, but rather in proportion to quite opposite conditions; that an increased yield of fibrin corresponds not to the rise, but to the decline, of albuminous material; that its relations are not with repair, but with waste; that its significance is that of something intermediate between life and excretion."

(1.) The *Fever* of inflammation was formerly supposed to arise from the increased proportion of fibrin in the blood, or hyperinosis, as the cause of febrile excitement of the circulation, and the other functions involved. Hunter advocated this interpretation of inflammatory fever, and he gave cases which, as tested by venesection, seemed to support it.

But the recent results of chemical analysis indicate that inflammatory fever may possibly be absent with hyperinosis, or present without it; and they certainly prove beyond doubt that the degree of inflammatory fever cannot be measured by the amount of hyperinosis. MM. Becquerel and Rodier estimate the increase of fibrin in various diseases to range from the healthy average of three to ten parts in one thousand of blood; and that a slight increase from three to five takes place in chlorosis, in certain cases of scurvy, more especially when it assumes the chronic form, during pregnancy also, and in erysipelas of the face; yet surely the two first mentioned diseases are not inflammatory, nor are the ordinary constitutional symptoms of pregnancy those of inflammatory fever. On the other hand, a diminished proportion of fibrin below the average of three in one thousand was noted in scarlet fever, small-pox, and measles; but the ordinary type of these fevers is inflammatory in a high degree. Lastly, when present, the degree of this fever does not correspond with the amount of hyperinosis. A great increase of fibrin up to ten in one thousand was noticed in acute articular rheumatism, in pleurisy, and pneumonia; and a proportion varying from five to ten was also found in peritonitis, bronchitis, and severe erysipelas of the face—diseases which are accompanied with at least as high a degree of inflammatory fever as pleurisy or pneumonia.

(2.) The foregoing facts and considerations compel us to attribute the accompanying inflammatory fever to some other source than the blood; and the only other bond of sympathetic connection between the heart and inflamed part is the nervous system.

Many years since, Abernethy suggested this channel of communication, and subsequently, Travers pointed out the agency of the nervous system, and drew the distinction between nervous excitement alone and inflammatory fever. Although he attributes this fever to excitement of the circulation from hyperinosis, yet he observed that the first morbid impression was upon the nervous system, and transmitted by the nerves of the part injured or inflamed to the nervous centre, and thence to the organs of circulation. In proof thereof, Travers urges the *priority* of nervous excitement in the development of inflammatory fever. The *premonitory* symptoms, viz., headache, lassitude, disquietude, nausea, chilliness, and rigor, are indications of the more or less troubled condition of the nervous centres; to these the alterations in the measure and force of the circulation, the permanent and sensible changes upon the internal and external surfaces, and their secretions, *succeed*—viz., quick pulse, hot skin, dryness of the mouth and fauces, furred tongue, vitiated and scanty secretions.

(3.) But the chemically changeful state of the textures, and thence of the blood in circulation, with the evolution of heat, are the essential constituents of inflammatory fever; and its symptoms are those of this more active change and increased temperature. There is, observes Mr. Simon, an accelerated devitalization and destructive transformation of organic material, which infects the blood through the venous and lymphatic outflow; the general mass of blood, thence

receiving corresponding increments of heat, and an unwonted afflux of chemically changing material, thus in its turn undergoes similar changes, chemical and calorific; and this process is then extended, through the circulation of the blood, to all the textures in the body. Every tissue, according to its chemical mobility, participating in the excitement, thus reflects in a lesser degree the disorder of the inflamed part, and contributes its share to that overproduction of waste material and of heat which characterizes inflammatory fever. As the blood gets hotter and hotter, more and more do the symptoms of fever become developed; as the blood subsequently gets cooler, so do they decline. The "crisis" of febrility consists in a rapid, and generally continuous, rise of temperature; the "lysis," in a slow, and usually intermittent, return to the normal standard.

Certain of the phenomena which precede and accompany inflammatory fever are difficult of explanation. I allude more particularly to inappetency and thirst. Healthy hunger and thirst are now generally allowed by physiologists to be sensations expressing corresponding requirements of the system, rather than proceeding from conditions of the stomach. These sensations, observes Dr. Carpenter, bear no constant relation to the amount of solid or liquid aliment in the stomach, whilst they do correspond with the excess of demand in the system over the supply afforded by the blood; and they abate by the introduction of the requisite material into the circulating blood, even though this be not accomplished in the usual manner by the ingestion of food or drink into the stomach. Agreeably to this physiological provision, inflammatory fever should be attended with hunger, rather than inappetency. Albumen is the pabulum most extensively demanded by the tissues for their support, and its proportion in the blood declines considerably during inflammation; yet this deficiency is accompanied with the loss of appetite. Again, the secretions are suppressed, and water, therefore, retained in the blood; yet this excess is attended with incessant thirst.

The rise of temperature—to perhaps 107° Fahr.—during inflammatory fever may be due, partly, to suppression of the perspiration, whereby heat is retained which would otherwise pass off by evaporation from the skin; and the excited nervous system probably contributes to the actual production of heat. But the principal source of increased heat would appear to be the chemical changes in the textures of the inflamed part.

Causes; *External* and *Internal,—Exciting* and *Predisposing.*—In common with most diseases, the etiology of Inflammation relates to causes without and within the body; and the latter, at least, may have either an immediate, or a predisposing causative influence.

The *External* causes of inflammation are manifold, but they may all be comprehended under four heads:—(1) Mechanical injury or irritation, as wounds, fractures, dislocations; or foreign bodies, introduced into the organism, as grit, portions of clothing, a splinter of wood, a bullet, and parasites, animal and vegetable; (2) Heat and Cold; (3) Chemical agents which decompose or kill living animal matter, as strong acids, caustic alkalies, chloride of zinc, and other escharotics; (4) Vital irritants, or animal and vegetable poisonous matters, and some mineral poisons; as the venom of noxious animals and plants, cantharides, mustard, capsicum, essential oils, arsenic, etc.

Internal causes may be either of an exciting character, in having an immediate action; or predisposing in their operation.

Exciting internal causes comprise the blood, textures, and excretions of the body, severally, under peculiar circumstances; and morbid products, organized and unorganized.

Blood extravasated and decomposing is a foreign body. So also are the various textures, when dying or dead; in the form of slough of the soft tissues, sequestrum of bone. The various excretions, as urine, fæces, bile, are irritants to the organs which naturally contain them, if such matters be in a state of decomposition; or if, being themselves healthy, they are extravasated; as urine into the scrotum, feculent matter into the peritoneum. These excretions are peculiarly obnoxious to cellular texture and serous membrane. Lastly, morbid products are apt to excite inflammation. Of deposits, softened tubercle does so in the lungs and other parts; of growths, cancer especially has this effect, the ichorous discharge more particularly being irritating. Calculi are familiar examples of unorganized products exciting inflammation in organs where they occur. For example, a stone in the kidneys provokes nephritis; in the bladder, cystitis.

All exciting causes of inflammation, in regard to their *modes of action* on the part affected, may be referred perhaps to two types: the stimulant kind, like heat, which acts as an excitant of textural changes in the nutrition of the part; the depressive kind, like cold, which acts as a textural depressor.

Predisposing internal causes include all those conditions which, co-operating locally, would constitute inflammation; or which, as systemic conditions, incline towards inflammation. The body is thus rendered susceptible to the influence of exciting causes. But the predisposition differs relatively, according to the nature of the cause which excites inflammation. For example, an excited state of the vascular system favours the production of inflammation from local irritation; whereas, a depressed state of the vascular system favours the development of inflammation from exposure to cold.

It is not easy to refer an inflammatory predisposition to any one element of inflammation; but an approach to certain illustrations of their respective influences is exhibited by the inflammation of different parts, wherein one or other of these elements predominate.

Thus, *tissues* in a devitalized state, and ready to die under the action of stimulants or depressors, are prone to inflammation; but tissues whose reproductive power is greatest, and which are commonly also most *vascular*, are equally predisposed; as, for example, the skin compared with fibrous or tendinous structures; or tissues whose productive power is temporarily exalted, as during the growth of the body in childhood and youth. The more vascular organs are similarly inclined; the lungs, for example, as compared with most other organs. On the other hand, a deficient supply of blood to a part inclines to inflammation by textural starvation; as in incipient senile gangrene. The *condition* of the *blood* is specially influential; poorness of blood—spanæmia—depending on a deficiency of animal food, is apt to induce inflammatory affections of low type, by defective nutrition; rheumatic and gouty inflammations are ever impending when an excess of lactic or of lithic acid, respectively, is in circulation; the retention of urea in the blood, as in Bright's disease of the kidneys, leads to inflammation of

the serous membranes; and suppressions of the excretions in general, have other inflammatory tendencies; while the introduction of irritant poisons into the blood gives rise to inflammation in different organs,—arsenic gaining admission through an ulcer, leads to gastritis, and blistering by cantharides produces bloody urine. It would seem that at least some such inflammatory affections are natural efforts to eliminate the poisonous matter from the system. Thence the predisposing influence of constitutional conditions generally, most of which are blood diseases manifested by various local inflammations, and ever ready to recur; as secondary syphilitic diseases of the skin and other parts, scrofulous affections of the bones, skin and other textures. Other blood conditions predispose, as unquestionably, to local inflammations; but they require for their development the co-operation of external exciting causes—contagious matters—in each case peculiar, relatively to the special condition of blood, which is thereby brought into action. All the infectious and eruptive fevers are of this kind.

Predisposition through the influence of the *nervous system* is evoked by nerve injuries, the operation of which in producing peripheral inflammation is thus generalized by Simon:—A part deprived of sensibility becomes specially incapable of protecting itself against mechanical and chemical irritants, and accordingly inflames—*e.g.*, the urinary bladder, subject to the action of retained urine, in paralysis. A part injured in respect of its innervation, is likely to suffer some circulatory disorder, with corresponding disturbance of natural temperature, and proneness to inflammation.

The *co-operation* of all these elements will render the predisposition complete, and almost give rise to inflammation. Thus, the functional activity of any organ implying the concurrence of all the conditions essential to nutrition, in excess, such activity is accompanied with a proportionate proclivity to inflammation; as in the mammary glands, after parturition when lactation commences, and during its continuance; or the ovaries at the period of menstruation.

The *operation* of inflammation itself is both local and constitutional.

Locally, inflammation operates by extension, continuously, in the texture or organ affected; contiguously, to parts adjoining; or, by transference (metastatis) to a part remote from that originally affected, the primary inflammation then subsiding.

Continuous extension is witnessed in the progress of inflammation along the skin or mucous membrane, as in erysipelas, and the sore throat of scarlet fever.

Contiguous extension is illustrated by ulceration of the articular cartilages of any joint, consequent on caries of the adjoining head of bone, or on synovitis. Thus also ostitis supervenes on periostitis; cellulitis on inflammation of the skin, and conversely. Taking internal organs, from the head downwards: meningitis is succeeded by cerebritis; scrofulous and purulent ophthalmia, by inflammation of the cornea and deeper textures of the eye; laryngitis, by inflammation of the subcellular texture and œdema glottidis; gastritis, enteritis, cystitis, and metritis, respectively, may extend to the peritoneum, giving rise to peritonitis.

The *transference* of inflammation is exemplified by orchitis supervening on the sudden suppression of gonorrhœa.

Such then is the general operation of Inflammation locally; con-

stitutionally, its operation was traced in the origin and development or the pathology of inflammatory fever.

COURSE and TERMINATIONS.—Inflammation may proceed to either of four Terminations: Resolution, or disappearance; Effusion, or lymph-production; Suppuration, or pus-formation; Ulceration and Mortification, or death of texture. Excepting the first of these terminations, that of resolution or simply cessation of inflammation, the line of demarcation between each of the remaining three modes of termination, is indistinct, and they are commonly more or less combined. A more definite line of distinction may be drawn between them, by regarding the course of inflammation in reference to its two principal constituent elements; increased productiveness, and increased destruction, of texture. According as one or other of these predominates, so may we associate therewith the remaining terminations of inflammation respectively; as effusion, and suppuration; ulceration and gangrene.

1. *Resolution.*—Inflammation may subside and terminate without any permanent structural result. The redness fades away, the part recovers its healthy temperature, slight swelling if perceptible subsides, and exalted sensibility or pain ceases; while any inflammatory fever passes off. This is resolution; a termination of inflammation by the concurrent cessation of all the elements of this process; and consequently, the cessation of its local and constitutional manifestations.

2. *Productiveness* may predominate; then, Inflammation proceeds to Effusion, or, perhaps, Suppuration—an increase of new material in the part, beyond the small proportion which necessarily attends inflammation. Liquor sanguinis appears, consisting of coagulable lymph and serum. In the latter constituent, the proportion of albumen and of salts is increased; but of these there is a larger proportion of chloride of sodium and phosphates than in the blood, as shown by Lehmann, and Dr. L. Beale.

Three conditions of lymph may be distinguished by tolerably well marked structural characters; the fibrinous and the corpuscular of Paget, and a transition condition, consisting of both fibrils (filaments) and cells, the latter predominating. Similar susceptibilities of organization represent the varieties noticed by Dr. C. J. B. Williams, as the euplastic, aplastic, and cacoplastic. They differ also in point of vascularity, in the course of their development.

With these typical conditions of structure are associated tolerably definite physical properties. Fibrinous or Euplastic lymph—transparet, nearly colourless, and tenacious. Corpuscular or Aplastic lymph—opaque, yellow, diffluent. Transition condition or Cacoplastic lymph—opaquish, yellowish, and less tenacious than the euplastic type. These characters are more clearly contrasted when placed in juxtaposition.

LYMPH.

	Fibrinous.	Transition condition.	Corpuscular.
Physical properties	Transparent. Colourless. Tenacious.	Opaquish. Yellowish. Tenacity less.	Opaque. Yellow. Diffluent.
Structure	*Fibrils.* Cells. Blood-vessels.	Cells. Fibrils. Blood-vessels few.	*Cells.* Granules. Blood-vessels absent.
	Ex. False membranes.	Ex. Cirrhosis.	Ex. Pus.

The qualities of lymph are certainly most obvious when it is effused from simple membrances, as the serous—for instance, pleuritic effusions; while the more complex structure of skin and mucous membranes retard its separation, and modify its properties by the admixture of their own secretions. Hence the varied products of skin diseases, and those discharged from the gastro-intestinal canal, the urinary and pulmonary passages.

It will be desirable first to describe, more particularly, the elementary products of Effusion, including Suppuration; and then, their apparent source and mode of production, or the pathology of Effusion.

Products of Inflammation—Effusion.—(1.) Coagulable lymph is more or less tenacious and at first transparent, but it acquires a slightly opaque yellow colour. It is produced in the form of minute villi. This appearance is best seen on free surfaces which are least subject to motion or pressure; as between convolutions of the intestines in peritonitis, between the lobes of the lungs in pleurisy, and about

FIG. 16.*

the base of the heart in pericarditis. (Fig. 16.) But wherever serous surfaces are in contact and play upon each other, the ductile lymph is drawn into threads or plastered into films; as on free portions of the pericardium and pleura, and on the parietal aspect of the intestines.

Coagulation having taken place, coagulated lymph is somewhat solid, though still retaining its tenacity and opaquish yellow colour. Its organization, in this its simplest condition of structure, is that of fine filaments, interwoven in various directions; as in the buffy coat of the blood. These filaments are formed apparently by the linear union of molecules and they vary from $\frac{1}{14000}$ to $\frac{1}{10000}$ of an inch in diameter.

* Pericarditis showing villiform lymph. (Bennett.)

(2.) *Cells* or corpuscles appear in coagulable lymph, and are found interspersed among the molecular formed filaments, in coagulated lymph. These cells contain each from three to eight granules, the diameter of which equals that of the filaments. The cells themselves range in size from $\frac{1}{1300}$ to $\frac{1}{1000}$ of an inch. (Fig. 17.) They have been named plastic by Dr. Bennett, because occurring so often in plastic lymph; and also named pyoid by Lebert, from their general resemblance to pus corpuscles. But neither water nor acetic acid much affect these plastic cells. Most probably, they are altered white corpuscles of the blood, which have emigrated.

FIG. 17.*

Cells of this kind undergo development. By elongation, they assume an oat-shape; prolonged yet further in opposite directions, they are attenuated into filaments,—forming fibre-cells. Thence is produced *fibro-cellular*, or *connective*, tissue, generally the highest state of organization of inflammatory effusion. (Fig. 18.)

FIG. 18.

Blood-vessels are found in organized inflammatory lymph, and possibly in coagulated lymph, but they do not appear to be formed in it; they project into the new tissue from the structure on, or in, which it is placed. The vessels are formed by the same process of sprouting, coalescence, and construction of loops, as in granulations. Lymphatics were discovered by Schroeder Van der Kolk in false membranes. Nerves have been twice seen by Virchow in adhesions; one of the pleura; the other of the peritoneum, between the liver and diaphragm.

False Membranes are formed on the inner or free surface of serous and of mucous membranes; as in pleurisy, pericarditis, and peritonitis; in croup, and dysentery. Such membranes consist of inflammatory

* Molecular fibres and plastic corpuscles, in simple exudation on a serous surface. Above are corpuscles after the action of acetic acid. 250 diam. (Bennett.)

lymph, which has undergone more or less development; and on serous surfaces, it may reach the state of organization just described, that of fibro-cellular tissue, supplied perhaps abundantly with blood-vessels.

The physical characters of false membranes vary according to their more or less high degree of organization and vascularity; the membrane formed is either pliant and yielding, or tough and unyielding.

Adhesion is apt to take place when the opposed surfaces of a serous cavity lined with inflammatory lymph, meet together. Similar adhesion may take place in wounds, or under other circumstances. Any such result of inflammatory lymph-effusion is sometimes referred to *adhesive* inflammation.

Other and more highly developed tissues are reproduced. Many such results of inflammatory lymph-production are adduced by Paget. Adipose tissue may be formed, if not directly from inflammatory lymph, yet in the fibro-cellular tissue of completely organized adhesions. Elastic tissue is sometimes abundantly formed in the adhesions developed from inflammatory lymph, and particularly in those of the pleura. Epithelium covers the surfaces of well-formed adhesions. Fibrous tissue is produced from the development of inflammatory lymph, interstitially deposited in any fibrous tissue; as in ligaments, capsules of joints, etc. Bone is often formed, either as a late transformation of inflammatory lymph, which had become organized into perfect fibrous tissue; *e.g.*, osseous plates in false membranes of the pleura, and in those of the pericardium, which plates are not true bone; or new bone appears in the form of ossific deposits, connected with inflamed bone or periosteum. Cartilage may be produced in chronic rheumatic arthritis. This new cartilage is prone to ossify.

FIG. 19.*

Lymph-effusion may undergo *absorption;* or if persistent, its operation may be either destructive, or reparative and constructive, and accordingly unfavourable or favourable to the function of the organ or texture affected.

Destructive consequences of lymph-effusion are illustrated by many organs. The heart may be shackled by tags of false membrane, which continually restraining the action of this organ, at length induces its hypertrophy; a compensatory provision of increased structure for extra contractile power. Or the heart may undergo compression by great thickening of the cardiac reflexion of the pericardium, in consequence of the interstitial deposition of lymph therein (Fig. 19); and thence, eventually, the organ be-

* Great thickening of cardiac reflexion of the pericardium. Sudden death while turning in bed.—*Author.*

comes atrophied. The lungs may suffer in like manner, either way. Peritonitis is apt to agglutinate the abdominal viscera into one mass. Within the substance of parenchymatous organs, contractile lymph being deposited, they become stuffed, consolidated, and sometimes atrophied and granulated. Such are old hepatized lungs, cirrhosed liver, and granular kidneys. Strictures are liable to form around canals, as the œsophagus, rectum, and urethra, narrowing or closing them and thus interfering with the functions of these passages. Eventually, displacements of movable viscera are wrought by the slow contraction of lymph-deposit, overcoming the struggle of function to recover the right adjustment of parts. Analogous mischief may happen to the mechanism of the limbs; joints become stiffened by firm fibrous anchyloses, the tendons are bound in their sheaths, and the fasciæ agglutinated, in chronic rheumatism.

This fettered condition of organs, their compression, consolidation, and atrophy, obstruction, and displacements, are the principal destructive results of lymph-effusion.

On the other hand, its operation is not unfrequently reparative, to reinstate an old function, or constructive, to fulfil a new and useful purpose.

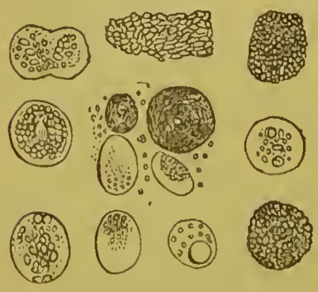
The *reparative* power of adhesive inflammation is manifested by the healing of incised wounds in those cases where the effusion of lymph is induced by inflammatory hyperæmia. The repair of simple fracture and of simple dislocation, when reduced, is an analogous process, and commenced probably by inflammatory hyperæmia consequent on the injury. So, also, wounded arteries are permanently closed by adhesion of an inflammatory character in some cases; and the healing of ligatured arteries is certainly effected by adhesive inflammation, which seals the divided coats of the vessel above and below the line of ligature. Penetrating wounds of the thorax and abdomen, implicating the viscera, afford ample and varied evidence of the reparative power of adhesive inflammation. Wounds of the lung are healed by adhesion of the pulmonary pleura consequent on inflammation. Wounds of the abdominal viscera are healed in like manner wherever the peritoneal investment extends; and the visceral reflexion of the peritoneum is very apt to adhere to the parietal reflexion of this membrane opposite the external wound. These results are explained in describing the healing of wounds of the abdomen and thorax respectively. In certain cases the peritoneum is purposely injured by the surgeon, so as to establish adhesive inflammation. This constitutes the radical cure of hydrocele and that of hernia; the former being accomplished by a stimulating injection, the latter by long-continued pressure with a truss; or the radical cure of hernia may be accomplished on the same principle by the successful operation recently introduced by Mr. Wood. Lastly, among the most familiar examples of beneficial adhesive inflammation, I may mention the well-known fact that foreign bodies, long imbedded in the living tissues, thus become enclosed in organized lymph, and their presence rendered comparatively harmless. An encysted foreign body is quiescent.

Constructively, we observe inflammatory adhesion preventing suppurating, or confining its extent, in the pleura, or in the peritoneum, occasionally; in the synovial capsules, and determining the boundary of an ordinary abscess; beyond which circumscribed limit, in any case,

the pus formed cannot pass. Then, again, the same process prepares the way for the discharge of pus, without infiltration of the textures during its passage or escape into any natural cavity through which it may traverse. Any collection of matter having become circumscribed —as an abscess—by the deposition of inflammatory lymph, it is thus also gradually conducted through the surrounding textures at their most yielding point; the pathway having been previously paved securely for this purpose by their adhesion. An abscess is thus advantageously opened by Nature. Absorption makes the channel, and in the direction of least resistance; but adhesion makes its banks secure. With this precaution a collection of matter is safely conveyed from a great depth in the body, and by an otherwise dangerous route. Witness the evacuation of pus from the pleura, in empyema, through a large and pendulous mamma. Adhesions of other serous surfaces favour the escape of matter. When a student, I once saw an abscess of the liver which pointed and threatened to burst externally, but which eventually relieved itself by perforating the diaphragm and right lung successively; a continuous expectoration of pus being provided for by adhesion of the pleura where perforation had taken place. Sometimes, by a similar provision, an abscess of the liver discharges itself externally, or into the stomach, the duodenum, or the colon. An abscess of the kidney will also thus communicate with the colon; and an abscess in the right iliac fossa will be emptied into the colon, cæcum, or bladder.

(3.) *Exudation corpuscles* are round or irregular little masses, having a dark and mulberry-looking appearance, under the microscope. Their size is about $\frac{1}{1000}$ to $\frac{1}{750}$ of an inch in diameter. They consist of granules aggregated together, and sometimes enclosed in a cell-membrane; hence they are named also compound granular corpuscles. (Fig. 20.) Within each of these corpuscles is seen a round transparent nucleus, varying in size from $\frac{1}{5000}$ to $\frac{1}{3000}$ of an inch in diameter. The granules vary from $\frac{1}{12000}$ to $\frac{1}{6000}$ of an inch. They are fatty. Acetic acid does not affect the cells or masses; but they dissolve immediately in ether, and disintegrate under the influence of potash or ammonia.

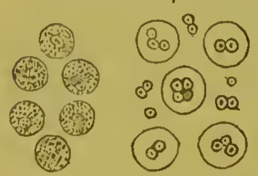
FIG. 20.*



(4.) *Pus* is a fluid having peculiar physical characters; an opaque greenish-yellow colour, diffluent or creamy consistence, faint odour, and an average specific gravity of 1030, but varying considerably from 1020 to 1040. All the characters of healthy pus differ considerably in the many diseased states of this product.

This fluid consists of a serum in which are suspended an innumerable multitude of corpuscles. (Fig. 21.) They are spherical, somewhat granular-looking cells, from $\frac{1}{200}$ to $\frac{1}{300}$ of a line in diameter; and consisting of a cell-membrane, enclosing granular or molecular matter, and a nucleus situated, generally, on the interior of the cell wall and adherent. It varies in size from $\frac{1}{800}$ to

FIG. 21.†



* Granular cells and masses from cerebral softening. (Bennett.)

† Pus-corpuscles, as seen in healthy pus; the fine transparent cells are as seen after the action of acetic acid. (Bennett.)

$\frac{1}{400}$ of a line across, and consists of two, three, or four granules aggregated together. These secondary nuclei are round, oval, sometimes elliptical. The whole cell,—its membrane, and contained molecular matter and compound nucleus, are albuminous. Water distends these corpuscles, and acetic acid dissolves the molecular matter, perhaps also the cell-membrane, and by loosening or breaking up the nucleus, displays its compound structure. (See Fig. 21, the five transparent cells.)

Pus-serum is a clear, colourless, or very faintly yellow fluid, having a weak alkaline reaction, and coagulating by heat into a dense white mass. Albumen is its chief constituent, in proportion from 1·2 to 3·7%. Fatty matter is extracted by ether, and it consists of olein, margarin, oleic and margaric acids, and cholesterin. These fatty matters vary from 2 to 6% of the whole fluid, of which proportion, cholesterin alone often reaches to 1%. Mucin, pyin, casein, chondrin, glutin, and leucine, are occasional constituents. The solid constituents of this serum range from 14 to 16%, of which from 5 to 6% are mineral, and the soluble salts are to the insoluble as 8 to 1. Of the former, chloride of sodium is most abundant, being three times more so than in the serum of blood. The soluble phosphates range from 3 to 10%. The insoluble salts are phosphates of lime and magnesia, with a little sulphate of lime and peroxide of iron. Certain incidental matters may be present in pus, as in any other exudation; namely, bile-pigment, the resinous acids of the bile, urea and sugar. (Day's "Chemistry.")

Pus is seldom found pure, but associated with various ingredients, the *débris* of surrounding textures, and mixed with secretions. Healthy or laudable pus may thus become serous, mucous, sanguineous, strumous, cancerous, etc. Or pus may be specific; as the syphilitic pus, vaccine matter, pus of porrigo, of glanders, etc.

The products of Inflammation are usually found associated; but one or other so far predominates, in different textures or organs, as to give its own structural character to the deposit; in cellular texture and parenchymatous organs, as the lungs, the product is chiefly granular matter and exudation corpuscles; in or on mucous membranes, chiefly pus; on serous membranes, chiefly coagulable lymph.

Pathology of Effusion and of Suppuration.—Analogy would lead us to expect a general resemblance between the processes of healthy nutrition and inflammatory effusion;—that the composition and vital condition of the blood will predispose to the formation of certain products; and that this process is affected by the degree of inflammatory hyperæmia, and by the force of the general circulation; that it is regulated by the nervous system; and is completed by the secretory or the formative power of the inflamed structure.

How far does all this anticipation accord with known facts?

(*a.*) As to the condition of the blood, in its relation to inflammatory effusion. Serum exudes from the engorged vessels, and fibrin, therefore, may also escape in a fluid state. But inflammatory blood superabounds with fibrin, and this condition will tend to deposit it more freely. The liquor sanguinis effused will be, for the most part, fluid fibrin; and such is the typical character of coagulable lymph, which represents the first product of inflammation, before the formation of filaments, or of exudation, or pus-corpuscles. It is that which appears in the first instance on blistered surfaces, as demonstrated by Paget's observations.

(*b*.) The quantity of liquor sanguinis, and therefore of fibrin, effused, is further regulated by the degree of hyperæmia, aided by the force of the general circulation.

Virchow denies this explanation of fibrin-production. He argues that nobody has ever been able to prove the affirmative experimentally; that nobody has ever been able, by producing a mere change in the force of the current of the blood, to induce the fibrin to transude directly, as it is wont to do in certain inflammatory processes; for this, some irritation is always required. But, in the absence of experimental proof, clinical observation supplies, I think, some probable evidence. When the pulse is strong and hard, the blood-stream beats forcibly through unyielding vessels, in an inflamed part; then fibrin is produced abundantly in that part. When, again, the pulse is rapid rather than strong, and compressible, the blood current is misdirected; then less fibrin is found in the part inflamed. The former condition is illustrated by common phlegmonous inflammation, with much fibrin; the latter, by erysipelas, with much serum.

(*c*.) Beyond these causes of lymph-effusion, it is possible that the character of the deposit may be influenced by the nervous system; but the share of its influence, if any, must be determined by future inquiry.

(*d*.) Lastly, the structure in which inflammation takes place, may itself exercise some power, either by selecting the fibrin from the blood, thereby inducing its effusion, or by producing it in the inflamed part through metamorphosis of the material effused. In other words, an inflamed structure may possess either a secretory or a formative power.

Virchow adheres to the latter view, and maintains by experimental observations, that irritation induces the effusion of a fibrinogenous substance, which can be converted into fibrin. In proof of the self-sufficiency of irritation, Virchow adduces the operation of a blister; that firstly, serum only is yielded, but if the irritation be more violent, a fluid which coagulates. The general doctrine advanced is thus stated:

A patient who produces at a certain point a large quantity of fibrin-forming substance, much of it passes from that point into the lymph, and finally into the blood. The exudation may therefore in such cases be regarded as the surplus of the fibrin formed *in loco*, for the removal of which the lymphatic circulation did not suffice. As long as the current of lymph does suffice, all the foreign matters which are formed in the irritated part are conveyed into the blood; but, as soon as the local production becomes excessive, the products accumulate, and in addition to the hyperinosis, a local accumulation of fibrinous exudation will also take place.

More consistent with known facts is the operation of a secretory power, by which structures select this or that constituent of the blood as it passes through them, and by which the effusion of that particular constituent is determined. An approach to the proof of this theory is, I conceive, the behaviour of the same blood in different textures. Blood, having the same composition and properties, deposits in one inflamed part much fibrin; in another, rather albumen; in a third, more fatty matter. In pleuro-pneumonia, for example, fibrin and a large proportion of serum are effused from the inner surface of the

pleura; an albuminous matter is deposited in the lung parenchyma; and pus, in which fat abounds, is more readily secreted from the (bronchial) mucous membrane. These products are known ingredients of the same blood, flowing alike to each of the three structures mentioned, and yet they severally receive a different kind of deposit. The inference is, that the particular deposit is selected or secreted by the particular kind of texture. How far this secretory power is a vital property, how far it results from the physical construction of the texture, is an open question. Assuredly the physical consistence and permeability of a part will very much affect its capability of receiving this or that kind of effusion.

Pyogenesis, or the origin and formation of *pus-corpuscles*, is a process respecting which various explanations have been propounded, but all of which may be resolved into two sources:—(1.) Derivation of pus-cells from some source *external* to the capillary blood-vessels. Dr. Redfern's original observations on cell-division in articular cartilage, subject to irritation, suggested the doctrine of pus-production by the proliferation of tissue-cells. Subsequently, similar observations on the cornea of the frog, by Virchow and Heis, confirmed this view. After cauterization with nitrate of silver, or after the passage of a seton, the corneal texture swarmed with young cells, apparently in various stages of endogenous development from the tissue-cells. Enlarging from this stand-point of experimental investigation; corpuscles or germs are said to abound in the cellular or connective tissue throughout the body, which, as a common stock, may generate pus-cells; and it is alleged that cell-growth results from irritation of the parenchymatous textures. Such is Virchow's theory of pyogenesis. Dr. Burdon Sanderson observes, that "a region is found outside the focus of suppuration, in which the connective-tissue corpuscles present alterations which are so distinct, that it is impossible for any one who is conversant with them to doubt that they signify that the tissue is germinating." This doctrine completely overturns the old theory of pus-formation by disintegration and solution of the textures. As Virchow expresses it, "Pus is not the dissolving, but the dissolved, *i.e.*, the transformed tissue; a part becomes soft, and liquefies whilst suppurating, as the result of the proliferation of the tissue."

(2.) *Effusion*, or exudation of the plasma of the blood, would appear to be the source of pus-cells, according to Rokitansky; and transformation of the exudation corpuscles was the doctrine propounded by Dr. Hughes Bennett. In either case, the source would then be from *within* the vessels. It is alleged that exudation granules aggregate and constitute a compound granular mass. An investing cell-membrane may gather round such a mass, as a nucleus. Both these are forms of the exudation corpuscle. Partial liquefaction of the peripheral granular matter of a cell-enclosed mass, may then give rise to a pus-cell, with its compound granular nucleus. The chemical metamorphosis of cell-contents, or the substitution of albuminoid for fatty granules, is not explained. But the structural relation of pus-cells to exudation corpuscles, would seem to be a degenerative transformation. Several such apparently transformative conditions of exudation corpuscles are represented in Fig. 20.

(3.) *Emigration* of the *pale blood-corpuscles* through the walls of the capillaries, is now the generally accepted interpretation of pyo-

genesis. The process of transmission has been already described. But the principal evidence in support of this being the source of pus-cells, may be thus stated. The structural resemblance or identity of pus-corpuscles, and the pale corpuscles of the blood, had long been known. Then the amœboid activity of pus-cells—no less than that which the pale corpuscles are known to possess—was shown by the original observations of Recklinghausen. But the evidence that pus-cells are pale corpuscles of the blood, rests upon two orders of facts respecting the results of irritation in a non-vascular texture, as the cornea of the frog. After a few days, the cornea assumes a yellowish opacity, situated invariably at the periphery of the centre of irritation; the inference being that the source of any pus-cells must have been extraneous to that centre. Then again, molecular colouring matter in contact with cells is known to be appropriated by them; accordingly, Cohnheim introduced aniline blue into the lymph-sac in the frog's back, and the pus-cells in the cornea were found to be tinted with this colour; whereas, on introducing the same material into the cornea, the corpuscles remained colourless. Similar results were obtained from the injection of cinnabar, by Hoffman and Recklinghausen.

Pus-production appears to be governed by conditions analogous to those which regulate the formation of other inflammatory products, and those of nutrition in general. "Secretory power" would seem to be in operation, regulated probably by "nervous agency," and determined by the "condition of the blood;" possibly also by the "flow of that blood to the part."

(*a.*) Pus has been termed a secretion; and its constant production in connection with certain textures, rather than others, although the blood be the same, plainly indicates that such parts possess and exercise some secretory or separating power.

The readiness with which mucous membranes suppurate is well known. Bronchitis, enteritis, and cystitis are prone to induce purulent sputa, fæces, and urine, respectively; indeed, pus has been found on a bougie five minutes only after it was introduced into the urethra. Other textures are far less prone to suppurate. An incision through the skin and subcutaneous cellular tissue probably unites by adhesion, without any suppuration, or pus is not produced for two or three days.

(*b.*) The pus-forming power of textures is probably regulated, like other secretory power, by the nervous system. In paraplegia, cystitis usually ensues, and this paralytic cystitis produces purulent urine in a more marked degree than cystitis arising from other causes. Injury of the fifth pair of nerves is followed by suppuration of those parts which they supply. Such cases show the effect of intercepting the nervous influence to a part; but the nervous system exhibits its influence by inflammation and suppuration of a part through sympathy with some irritation in another and perhaps distant part. Sir James Paget refers to a specimen in the Museum of St. Bartholomew's Hospital, where extensive deposits of lymph and pus were found in the testicle of a man whose urethra contained a portion of calculus impacted after lithotrity. The influence of mental emotion in producing inflammation with speedy suppuration is manifested by the following case, and of which there are similar ones. A lady was watching her little child at play, and she saw a heavy window-sash fall

upon its hand, cutting off three of its fingers. In a short time the mother also had inflammation of the corresponding three fingers of her own hand, and in twenty-four hours pus was evacuated by incision.

(*c.*) Pus-production is determined very much by the condition of the blood. One would suppose so, judging from the analogy between pus-secretion and other efforts of the secretory power. Certain experiments made by Paget supply apposite illustrations. They show that the same tissue, inflamed by the same stimulus, and as near as possible in the same degree of inflammation, yields, in different persons, and in whom therefore the blood may be considered dissimilar, different forms of lymph. The inference is obvious, that blood-conditions determine the kind of product which shall be formed, or, as we may say, secreted. Blisters raised by cantharides in thirty patients gave sometimes a fibrinous, sometimes a purulent, product. It was found that in cases of purely local disease, in patients otherwise sound, the lymph formed an almost unmixed coagulum, in which, when the fluid was pressed out, the fibrin was firm, elastic, and apparently filamentous. Whereas, in cases at the opposite end of the scale, such as those of advanced phthisis, a minimum of fibrin was concealed by the crowds of corpuscles imbedded in it. Paget therefore concludes that the highest health is marked by an exudation containing the most perfect and unmixed fibrin; the lowest, by the most abundant formation of corpuscles, and their nearest approach, even in their healthy state, to the characters of pus-cells.

(*d.*) Has continued determination of blood any influence in producing pus? It has been alleged by Dr. C. J. B. Williams, that such a result is most likely to ensue in complex and highly vascular structures, where the effused matter is retained in intimate contact with the blood-vessels; hence intensity and continuance of inflammation in the true skin, cellular textures, glands, and most parenchymatous organs, pretty surely lead to suppuration. But, if an incision be made when pus is about forming in a large boil, an abundance of solid lymph is seen agglutinating the cellular texture. Pressing as this does upon the vessels which it encompasses, they become, at least partially, occluded. And this obstruction, this solid lymph and agglutinated cellular texture, may extend for some distance, giving the external swelling a broad base. Around the periphery of the solid swelling blood plays freely, yet without pus forming there; whereas, in the centre, first appears a white spot of pus, far removed from the circumferential determination of blood. This afflux of blood goes on depositing fresh lymph, thus enlarging the swelling; while in the midst of the solid lymph and occluded vessels, more and more removed from all such external influence, suppuration proceeds. Persistent determination of blood, therefore, only prepares a structure for suppuration; suppuration itself is an independent process. Consequently, we are not surprised to discover pus in a texture where determination of blood cannot have availed much; as in the centre of a large fatty tumour, itself but ill provided with vessels for its own supply of blood; and the freest afflux of blood without suppuration, as in a gouty toe.

Signs of Effusion, and of Suppuration.—Inflammatory Effusion is attended with swelling, in consequence of the progressive accumulation of the products of effusion. The nature of this swelling may be

recognized partly by considering the physical character of the products; liquor sanguinis presenting a swelling, at first fluid, but as coagulation ensues, it soon assumes the character of a mixed product —solid and fluid, varying as either fibrin or serum prevails. Should the swelling be of doubtful character, the diagnosis can be completed by puncturing its substance, and if necessary by further examination with the microscope of the matter effused or the resulting products.

Suppuration is *announced* by a throbbing or pulsating pain, increased heat, redness, and swelling. But proceeding as these signs do from increased determination of blood; a condition not essential to suppuration—they are not invariably present, or followed by suppuration; the inconstancy, in either respect, depending on the kind of texture in which inflammation takes place. In any unyielding texture, inflammation is accompanied with a throbbing pain, without suppuration necessarily ensuing; toothache being a familiar example. In a loose parenchymatous texture, which more freely admits the afflux of blood, extensive suppuration may have supervened, without any previous throbbing; as in the cellular texture of the ischio-rectal fossa. On the other hand, with regard to increased swelling; in loose cellular texture, considerable effusion and swelling may have taken place without suppuration ensuing; while, in an unyielding texture, an abscess forms, without any previous increase of swelling.

The diagnostic value of these symptoms is perhaps fairly this: when suppuration *does* occur, in *unyielding* textures, it is invariably preceded by throbbing, with increased heat and redness; and, in *yielding* textures, by increased swelling. Otherwise, these are not constant signs of approaching suppuration. Consequently, they are not absolutely trustworthy as premonitory symptoms.

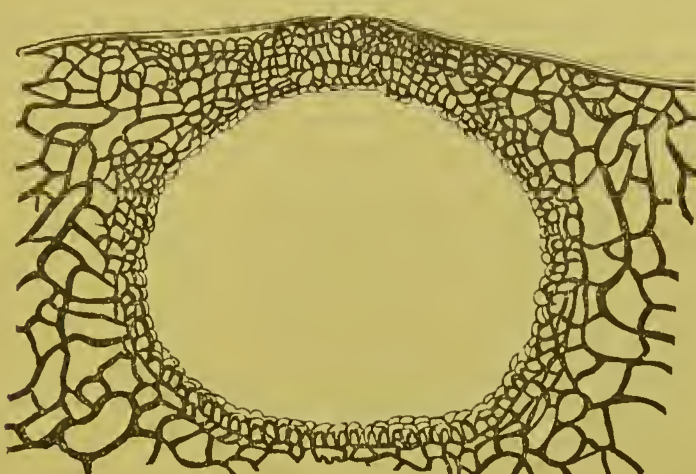
But the physical properties of pus confer certain distinctive characters on any soft part in which it is formed. Just as the first effusion of lymph is recognized by a semi-solid swelling, arising from the products—fibrin and serum—into which that lymph has become resolved; so now another product—fluid, but of creamy consistence, and slightly viscid—imparts a more elastic feel to the swelling. It is the sign of *diffused* suppuration, and this condition may continue, or a further change takes place.

Abscess.—Lymph may become deposited so abundantly around the focus of suppuration, as to effectually circumscribe and imprison the pus. The textures, thus encompassed, die, disintegrate, dissolve, and are removed by absorption, leaving the pus, more or less pure, in their place. An abscess is formed; which may be named *acute* or *subacute*, with reference to its more or less speedy formation; sometimes also termed a *hot*, or a *phlegmonous* abscess, as having regard to the sthenic character of the inflammation, or the firmly circumscribed boundary of solid lymph. A common boil is a good example of this form of abscess. It is the opposite condition of what has been termed *diffuse* abscess, which is nothing more than diffused suppuration. The circumferential lymph of this pus-containing cavity becomes highly organized, by the development of capillary blood-vessels, having a looped arrangement (Fig. 22); and it assumes somewhat the structure and characters of mucous membrane, and acquires a secretory power. It becomes pus-forming, as well as pus-containing; it is a *pyogenic*

membrane; and as it absorbs old pus, as well as secretes new matter, the abscess is gradually concocted or ripens.

The *Signs* are now those of abscess. The throbbing pain, heat, and redness, all the signs of previous active hyperæmia, are mitigated by the yielding resistance of pus as compared with that of partially solid lymph; unless the matter be confined under any unyielding texture, such as a fascia, or within bone. But a fluid and fluctuating, elastic swelling is presented, rather than one having the solidity of coagulated lymph, or the softness of pus diffused. To detect the presence of matter, a gentle tapping pressure with one or two fingers may suffice to convey the sensation of fluid; or, by this digitation on one side of the abscess, while the fingers of the other hand are lightly applied to the opposite side, a fluid stroke, or a wave-motion—fluctuation—will be more or less distinctly felt. According to the depth of the matter, so must these manipulations vary in degree; but the sense of touch varies also in different individuals, and the Student should lose no opportunity of gaining the "*tactus eruditus.*"

FIG. 22.*



Like any other structure, pyogenic membrane may lose its functional power; then, pus-secretion failing, while absorption continues and prevails, the abscess dwindles and gradually disappears; or, retaining its power unimpaired, secretion and absorption are, perhaps, equally balanced, and the abscess remains stationary and becomes *chronic*. This form of abscess often occurs in the cellular texture, but usually in connection with dead bone—necrosis—or within the substance of a bone, as in the head of the tibia; and in the lymphatic glands or the salivary glands, chronic abscess is not uncommon; although in these parts, owing to the constitutional character of the suppuration, this abscess is usually named *scrofulous*. The *signs* are still those of abscess, as a fluid, fluctuating swelling; but the pain is less, unless maintained by some source of irritation, as in necrosis, and there is little heat, or redness. Yet the pyogenic membrane may acquire a higher degree of secretory power; pus accumulates, the membrane itself grows proportionately, and the abscess enlarges. The pus-

* Section of abscess. (Diagram after Paget.)

secreting sac or cyst, thin and smooth, is gradually transformed into a thick, soft spongy membrane, slightly mammillated, and of a greyish or reddish brown colour; at the same time, the matter secreted generally loses the creamy consistence of pus in an acute abscess, and becomes converted into a thinner, sanious, flocculent or flaky, yellow fluid. The sac is attached to the surrounding textures loosely or closely. They are detruded and absorbed under constant pressure by the expanding abscess, and thus also the area or size of the fluctuating swelling increases; *slowly* attaining to perhaps a considerable size. Then the swelling has become more unlike that of an ordinary acute abscess, and, owing to the thickened induration, more resembles a solid tumour, for which a chronic abscess might be mistaken by an inexperienced surgeon. Allied to the chronic abscess is the *congestive*, or *cold*, also named *lymphatic*, abscess; which occurs, sometimes, in the cellular texture or in the glands of debilitated subjects; the part suddenly falling into suppuration, as a thin bag of matter, without any notable symptoms of abscess. Thus, in the loose cellular texture of the thigh or axilla, or in the neck, a nearly painless and perhaps colourless swelling appears, and which freely fluctuates when examined. This swelling is often of large size, and may rapidly increase; tending to burrow beneath the integuments, and in the cellular planes between the muscles. For, unlike an ordinary chronic abscess, the circumscribing wall of fibrin always remains thin and ill-defined; but the contained matter is similar—a thin, sanious, opalescent, yellow fluid, consisting of serum, with broken-down pus-cells, in a state of fatty degeneration. As compared with the healthy pus in an acute abscess, the matter in a chronic, or in a congestive abscess, is even more and more aplastic.

Course.—In a variable period, usually before an abscess becomes chronic, absorption of the pyogenic membrane itself begins, under the expansion of constant fluid-pressure. And generally, in the direction of least resistance the abscess *points;* the circumferential tissues undergoing absorption more readily, or yielding more, in that direction, as the expanding force there gains advantage. On the side of the abscess opposite to this thinning portion, the pyogenic membrane, according to Macartney's observations, actually grows thicker, and contracts so as to exercise some degree of expulsive power. A prominent point appears, tense, as with fluid; over which the skin assumes a dark livid tint, with a shining or glazed aspect, while the cuticle is shed in receding rings. Here fluctuation is most perceptible through the thinned integument, which at length becomes relaxed. This spot varies in extent, from a small point to an area the size of a shilling, or larger; and the margin is usually circular and well defined. Soon a small slough separates and pus escapes. Thus, also, in the case of mucous membrane, an aperture is formed; but serous membrane yields with a rent. Distension is relieved, and if the aperture be sufficiently free and dependent, or made so, the matter is discharged or drains away daily, coagulable lymph is effused instead, and forming granulations, it contracts towards the aperture, and gradually closes the cavity of the abscess. The residual abscess is now a healing *ulcer*, and the process of reparation is completed in a period varying from, perhaps, twenty-four hours to days, weeks, or months.

If contraction be incomplete, the sac of the abscess is brought to

gether only here and there, leaving intervening pus-producing cavities; a *multilocular* abscess is formed. Or, the cavity contracts into a long narrow channel, lined with a perfect pyogenic membrane throughout its course, and having an obstinate indisposition to heal; a *fistula* is formed. It may be convenient to distinguish a *sinus* by the absence of these characters. The latter is generally said to be distinguished from the former, chiefly, by its having only one opening; a sinus being a long, narrow, suppurating canal, opening externally or internally, and having little disposition to heal. But any such canal is an *incomplete* fistula; as may be fistula in ano.

Sometimes an abscess, after evacuation, acquires an unhealthy character, and remains without any tendency to heal. The sac secretes a fetid sanious pus, induced probably by the admission of air, or by some constitutional disorder affecting the pyogenic membrane, and the production of granulations is delayed. Or, at a later period, when the abscess is reduced to an ulcer, it, like ulcers arising otherwise, may exhibit an obstinate indisposition to heal. From constitutional causes chiefly, this ulcer may become irritable, inflamed, sloughing, or phagedænic.

The function of pus may be inferred from its relation to the process of healing by suppurative granulation, in a healthy ulcer or sore. The cells of pus are either degenerate or immature granulation-cells. If the former, pus represents the superficial portion of organized granulation-matter, which, having lived its time, passes off, just as the outermost epithelial cells are shed. If immature granulation-cells, pus represents the superfluous portion of organizable granulation-matter, which never reaches maturity. This is the more probable interpretation. Compare pus-cells—as unaffected by acetic acid—(Fig. 21, cells to the left), with granulation-cells (Fig. of granulation-structure, in this work), and their great similarity or identity will be obvious. As immature granulation-cells, pus ceases to be secreted when the granulations come to the level of the skin, for then, the ulcer being filled up, no more organizable material is needed. Suppuration may thus be associated with a restorative or reparative purpose; as in the closing of an abscess after evacuation of its contents, and in the healing of open wounds, compound fracture, and dislocation.

The situations where abscess originates are regulated, it would seem, very much by the different kinds of texture. Rarely, if ever, is abscess formed in fibrous or cartilaginous tissues, nor within any serous membrane. The situations where abscess may be found, are very various. It may have extended from its seat of origin to another, and perhaps distant, locality.

Abscess by *translation*, as any such extension is termed, somewhat inaptly, is favoured by various circumstances: by the difficulty with which pus produced in certain parts, finds its way to the surface; by the comparative facility with which it travels to other parts; by slow progress of the abscess, allowing opportunity for its extension; and by special circumstances conducing, which are peculiar to each case. Examples of such abscess occur chiefly in connection with the spinal column. Taking them from above downwards; abscess arising from disease of the cervical vertebræ, may present directly forwards behind the pharynx; or it may extend behind the sterno-mastoid muscle to the side of the neck; or into the axilla, or the thorax. From the

dorsal or lumbar vertebræ, abscess may present directly backwards, or forwards into the thorax or abdomen; or it may extend downwards—through the aortic opening in the diaphragm, in the case of dorsal abscess—and forwards, between the abdominal muscles, to some point in front of the abdomen; or to the external abdominal ring; or, guided, apparently, by the obturator vessels and nerve, to the obturator foramen, it points in the upper part of the thigh; or within the sheath of the psoas muscle to the upper part of the thigh, more externally, it appears as *psoas abscess*. Passing thence lower down, dorsal or lumbar abscess may point in the popliteal space, the calf, or even as low down as the ankle; or extending, from its seat of origin, downwards, and inwards, into the pelvis, the abscess may point at the side of the vagina, rectum, or sacro-sciatic foramen, or escaping thence, burrow externally between the bone and gluteal muscles, so as to present in the gluteal region. Abscess by translation is further illustrated, by extension from the seat of origin in the shoulder joint to the elbow; or from the hip to the knee. In the diagnosis of abscess by translation, any such extended collection of matter must not be confounded with *metastatic* or secondary abscess, consequent on pyemic infection.

The *Signs* of translated abscess are: a fluid, fluctuating swelling, like that of an ordinary abscess; but its concomitant redness, heat, and pain, are absent. Some degree of inflammation may ensue, from the weight of pus on the most dependent part of the abscess, and pain also may be experienced, owing to pressure on nerves in the neighbourhood.

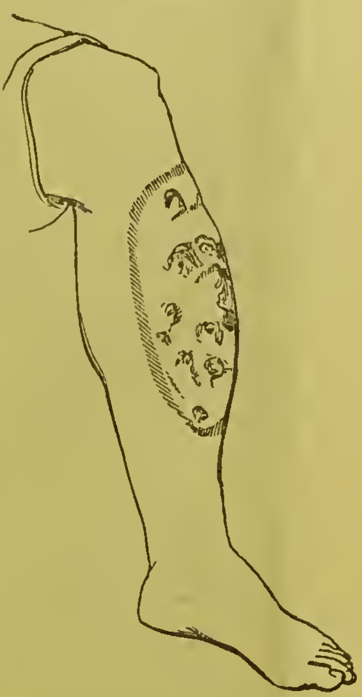
Fistula and *Sinus*.—The pathology of sinus and fistula has a wider significance than in relation only to abscess; for these passages may result from ulceration and sloughing, or from the imperfect healing of wounds. Generally, all these modes of formation depend on some local source of irritation; as a piece of dead bone, the escape of some secretion, as urine or feculent matter, and less frequently, bile, gastric juice, or saliva; and, the disturbing action of muscles in the neighbourhood of the part affected. Thus may be produced fistula in connection with necrosis or caries; perineal fistula, and vesico-vaginal fistula; fistula in ano; biliary, gastric, and salivary fistulæ; fistula from the healing of wounds in the limbs. Sometimes, two of the causes referred to may concur in producing fistula; as fistula in ano, resulting from abscess, caused by the escape of some feculent matter into the cellular texture adjoining the anus, and the closure of the abscess being prevented by the disturbing action of the sphincter ani muscle.

The *walls* of a fistula or sinus are lined with a more or less complete pyogenic membrane, secreting an unhealthy purulent fluid, in varying quantity, mixed perhaps with some other secretion. According to their indisposition to heal, these passages are more or less hard—callous, as it is termed, with condensation of the surrounding cellular texture. On introducing a probe up such a passage, it is found to be but slightly sensitive, or ready to bleed. An opposite state may be met with; the passage feeling soft or spongy, acutely tender, and bleeding freely; so that even under gentle pressure, the probe may easily penetrate the wall of the passage, and get out of the track.

The *orifices* of a complete fistula are two—an external or integumental, and an internal, leading into an abscess, or into some mucous canal or cavity, as the urethra or the rectum. Sometimes both orifices may be said to be internal, as in vesico-vaginal fistula. An incom-

plete or blind fistula, or sinus, has only one opening, which may be external or internal, whence such fistula is named accordingly. The *external* orifice presents certain varieties of appearance, which are practically important, as indicating the state of the fistula, or the presence of some source of irritation, local or constitutional. Thus, an inverted orifice, with a border of thickened and indurated integument, is connected with a callous and chronic condition of fistula; while an everted external orifice, presenting an out-crop of soft, spongy granulations, or "proud-flesh," may be connected with caries or necrosis, as the foreign body which maintains this indisposition of the fistula, or fistulæ, to close. (Fig. 23.) Other appearances may be dependent on some constitutional influence, as scrofula or syphilis. The *discharge* from a fistula, so long as the passage is indisposed to heal, is itself never of a healthy character; but it is less characteristic, contrasting only with healthy pus in being a thin, grumous, yellowish or reddish fluid, consisting of serum with broken-down pus-cells and blood corpuscles.

FIG. 23.



Besides the ordinary conditions of fistulæ, they are liable to assume the various diseased states of an ulcer; becoming irritable, inflamed, sloughy, or phagædenic. When manifesting a tendency to close, as a *healing* fistula, the pyogenic membrane, which had previously a mammillated or imperfectly granular surface, now forms healthy granulations, and the passage begins to contract and get smaller; while the external orifice is no longer inverted or pouting, but is beset with small, florid granulations, followed by cicatrization. The discharge also assumes the creamy consistence and appearance of healthy pus.

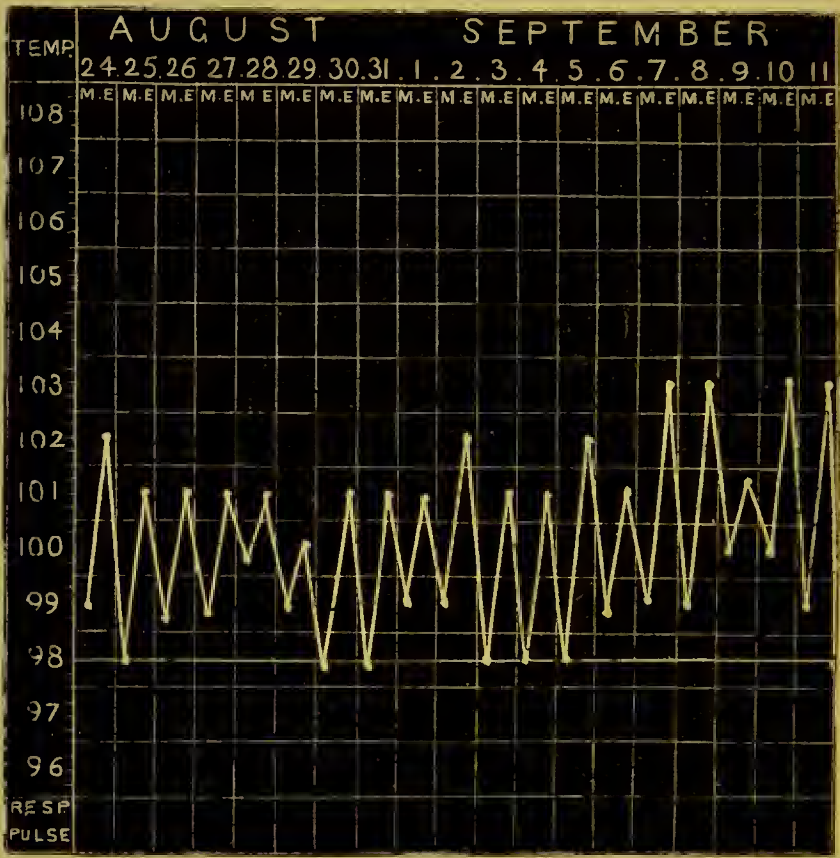
In this general description of Fistulæ, it is unnecessary to notice the various lengths of these passages, their irregular width, and their tortuous, and perhaps branched, directions; for although these particulars are, indeed, of practical importance, they pertain rather to the special pathology of organs and regions.

Hectic Fever.—The constitutional disturbance or hectic fever consequent on suppuration and abscess, is characteristic. Commencing at a variable period in the course of inflammation, the first symptoms are those of prostration with excitement. A sensation of chilliness or a shivering fit—rigors—announce the one, while the other—nervous excitement—is exhibited by restlessness and sleeplessness, the pulse also retaining its frequency, or rising in rapidity, although losing its force and hardness. The heat and flush of skin subside, a cold clammy sweat supervenes, the urine becomes pale, abundant, and deposits a pinkish sediment of lithates. The tongue loses its brown fur, is white and pasty with a bright scarlet tip; the appetite is very capricious, sometimes absent, with loathing of food and even vomiting; while profuse watery diarrhœa succeeds to the previous constipation. Pro-

gressive emaciation and trembling weakness bespeak the failure of nutrition; and the general course of the symptoms at length proclaims the victory of exhaustion.

Hitherto this fever has been uninterruptedly continuous with that of inflammation; but if it be prolonged, it acquires an intermittent character,—exhaustion prevailing, yet with recurring efforts of excitement, particularly of the circulation, followed by increased secretions from the skin, kidneys, and bowels. Thus, towards evening, after a day of dread exhaustion and when the skin is pallid, a chill is felt; soon the pulse rises in force slightly, and in frequency to perhaps 100 or 130 beats per minute. Then the patient temporarily revives; the hollow cheeks are crowned with a tint of crimson hue, and the sunken

Fig. 24.



eyes are lustrous; giving to youth and beauty a complexion and an expression which are not of this world. The palms of the hands and soles of the feet feel hot and dry. During the night or towards morning, this fitful fever abates with profuse perspiration, urgent liquid diarrhœa, and probably diuresis. Daylight is welcomed, but only with feelings of greater prostration.

The temperature in rigor, observes Le Gros Clark, rises always shortly before the commencement of an attack, and remains high for a varying period, commonly about half an hour after the shivering terminates; then it subsides gradually down to the degree from which it rose, or even lower. This diurnal rise and fall of temperature is well indicated in the annexed chart (Fig. 24), relating to a case of hectic

in a young girl, labouring under prolonged suppurative discharge from disease of the hip-joint, and on whom I operated in the Royal Free Hospital.

Such is hectic fever. Intermittent, it occurs at various periods; frequently as a quotidian, sometimes as a tertian or quartan. Thus far resembling other intermittent fevers, hectic has diagnostic differences. It seldom recurs at a period perfectly regular, for more than three or four paroxysms. Then recurring at irregular intervals, it may disappear entirely for ten or twelve days; unlike the course of ague. Moreover, the intermissions of hectic are not complete, the pulse still remaining above par, and very easily excited. It is rather a remittent fever. Hectic, therefore, may recur two or three times daily; and a very slight degree of emaciation, a pulse a little quicker than ordinary, with a slight increase of heat, particularly after meals, are sufficient to constitute incipient hectic. These are the earliest symptoms. Rigor is not necessarily the earliest, nor the most constant constitutional announcement of suppuration, and of approaching hectic. This symptom may be present without suppuration and consequent hectic, as the harbinger of an ague fit, or as arising during inflammation from exposure to cold; or from the mere introduction of a bougie into the urethra. On the other hand, hectic fever sometimes supervenes stealthily, without previous rigors.

Pathology of Hectic.—The causative relation of suppuration to hectic fever, would appear to be, not through purulent infection of the system, but through absorption of the disorganized textures, and therefore proportionate to the progress of suppuration.

(1.) Purulent infection is irreconcilable with known facts. Pus often exists in the body without hectic supervening, as, for example, in chronic diseases of the joints, and in psoas abscess. Probably, however, in such cases absorption is not very active. In other cases, pus is readily absorbed, yet without inducing hectic. A large bubo will sometimes subside in a few days without any symptoms of hectic, and every pus-secreting ulcer is liable to absorb its own secretion, and yet hectic is an unusual concomitant. Purulent absorption, therefore, is not a cause of hectic fever. Yet, I am not prepared to assert that hectic ever occurs without previous suppuration. Assuredly the quantity of pus formed is no measure of the degree of hectic which shall ensue; for after amputation, say, of a compound fracture, a much larger quantity of pus may form eventually, before convalescence, than had been secreted during the period prior to amputation, and yet the hectic shall subside.

(2.) Recovery follows the removal of the disorganized part. In some way, therefore, a causative relation exists between the disorganization of a part, and the supervention of hectic. It cannot be that the progressive destruction of nerves by suppuration, and the injury thence inflicted on the nervous system, gives rise to hectic, for the symptoms are not those of nervous irritation, and, moreover, they are intermittent, or at least remittent. This certainly looks as if some noxious matter was gradually absorbed and accumulated in the blood, until thrown off by a hectic paroxysm, again to re-accumulate. The matter in question is not pus, or if absorbed it does not infect. By exclusion we are led to infer that the morbid matter is probably the *débris* of the disorganized textures. Clinical observations and

examinations of the blood in hectic are wanting to confirm this view; meanwhile it is a significant fact, that the urine deposits lithates during the decline of each hectic paroxysm.

This interpretation of hectic indicates the relationship existing between the progress of suppuration and itself.

If hectic arises from absorption of disorganized textures, then it must increase with the progressive formation of pus: not that pus, in such case, itself infects, but because its formation necessarily implies the concurrent and corresponding absorption of the encompassing textures, and by thus poisoning the blood, induces hectic fever. Suppuration and hectic are, therefore, related indirectly, as cause and effect; and moreover, the quantity of pus accumulating or discharged, actually becomes a fair measure of the degree of hectic.

Certain acknowledged principles of preventive treatment admit of explanation by the theory I have advanced. Absorption of the textures is checked when the progressive accumulation of pus is prevented; hence, the importance of making an early, free, and dependent opening, which also allows any *débris* of the tissues to escape. Again, absorption of disorganized tissues is altogether prevented by removing them; hence, the necessity for amputation where their destruction is extensive and beyond hope of recovery to a healthy condition. Amputation under these circumstances is often followed by surprisingly beneficial results. As Hunter originally observed, a hectic pulse at 120 has been known to sink to 90 in a few hours after removal of the hectic cause. Persons have been known to sleep soundly the first night afterwards who had not slept tolerably for several preceding weeks. Cold sweats have stopped immediately, as well as those called colliquative. Purging has immediately ceased, and the urine begun to drop its sediment.

All these facts and considerations harmonize with the theory, that hectic fever arises from absorption of disorganized tissues. Pus itself sometimes, *apparently*, enters the circulation as pus; but this produces very different constitutional symptoms and results; those of *pyæmia*, followed by *secondary* abscesses. The circumstances under which purulent infection arises will be noticed more particularly in connection with that subject. Respecting the symptoms, it may be here summarily stated, that they are still those of a blood-poison, and of a typhoid character, but the exhaustion induced is more speedy, and more overwhelming,—more typhoid; and the poison is either not eliminated at all, or insufficient to allow of marked intermissions,—the fever is less intermittent, or more continued, than hectic.

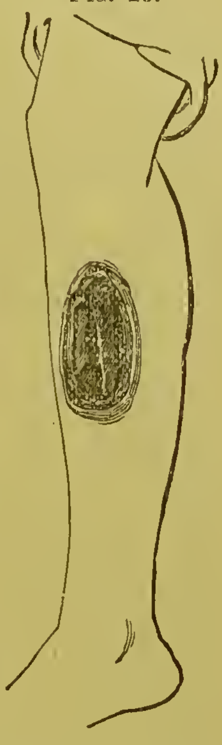
(3.) *Destruction* of texture, as the result of inflammation, comprises mortification and ulceration. (See Terminations, p. 73.) Mortification, or the death of a part, receives different names according to the partial and recoverable, or total and irrecoverable, loss of vitality in the part affected; the one condition being named *gangrene*, the other *sphacelus*. Both these terms refer to death of the soft textures, and when this takes place to a limited extent and is accompanied with ulcerative separation from the living textures, it is termed *slough*, and the process, a sloughing of the part; when bone is affected, mortification is called *necrosis*, and the dead portion, a *sequestrum*, and its separation, *exfoliation*. This latter term is sometimes restricted to the

detachment of an external portion of bone, in the shape of a thin scale or plate.

Ulceration may be conveniently described first, as being in its nature introductory to mortification.

The *phenomena* of ulceration generally, are these:—A portion of integument having become inflamed from any cause, after a few days a small piece separates and comes away, leaving a corresponding loss of substance—a chasm, from which a discharge, variable in kind and quantity, issues. Thus, then, the skin, or mucous membrane, with perhaps the subjacent cellular tissue, has undergone a "solution of continuity," slowly, however, as contrasted with a wound, or other recent breach of texture, and an *ulcer* is formed. (Fig. 25.) Its formation and extension constitute *ulceration*.

Fig. 25.



The pathological *nature* of this process has long been a disputed question. All the explanations advanced may be reduced to two heads.

Firstly, that ulceration signifies molecular disintegration, liquefaction, and separation of the soft parts, thereby leaving a chasm.

Secondly, that ulceration is an illustration of the process of absorption, the lymphatics and veins being jointly engaged, more especially the former.

Possibly, both modes of removing the disorganized textures, co-operate in ulceration. The evidence will be fully considered in connection with the *general* pathology of Ulceration (ch. iv.).

Textures undergo certain changes of structure preparatory to their ulceration. The latter is essentially *molecular disintegration;* but, in so far as it proceeds from inflammation, *degeneration* of texture prepares the way for such disintegration. And the previous degeneration is generally fatty.

The proper discharge from an ulcer—the product of ulceration, not of a granulating sore—is *ichor*. It is a thin sanious fluid, colourless or slightly yellow, structureless, but mixed with exudation, pus, and blood corpuscles, and with the *débris* of the ulcerating textures. Hence its variable appearance. Its essential chemical composition is unknown. Ichor corrodes the living tissues, and is thus distinguished from pus, which it often resembles in appearance. Thus also it maintains and extends ulceration.

Ulceration, although itself a destructive process, is somtimes restorative or reparative, in virtue of its purpose. For example, by the pointing of an abscess and the natural formation of an opening for the escape of matter externally, or internally into some channel through which it can be safely discharged, as through the bronchi, stomach, intestine, or bladder.

Mortification is only another mode in which any part of the body may die; a reciprocal relation subsisting between this process of destruction and ulceration. They differ in degree, but are one in kind. Ulceration may be exaggerated into mortification, and this may subside into that. Both are convertible by different gradations of the same process of destruction. Thus, now and then during ulceration,

some temporary cause may accelerate the inflammation; a larger portion of tissue undergoes degeneration and dies than can disappear as discharge, and this portion of dead tissue becomes visible in the shape of slough, instead of having been removed imperceptibly by molecular disintegration and liquefaction, aided by the corrosive action of the ichorous secretion. Accordingly the ulcer presents a rim of slough, and from time to time, another and another, as the margin of the ulcer recedes and enlarges, either by sloughing or ulceration. Of course the sloughs will vary in their depth and extent, sometimes approaching the result of molecular disintegration, sometimes appearing as obviously portions of dead tissue, plainly showing the transition of ulceration to mortification. Small fragments of bone may be detached and cast off with the fluid from an ulcerating surface, and these, observes Paget, when they are not fragments of tissue detached by ulceration extending around them, are good examples of the transition that may be traced from ulceration to sloughing or gangrene of parts.

Continued inflammation ends either in ulceration or mortification. And indeed the very fact of pus—a product of inflammation—accumulating in any texture or organ, by progressive suppuration, necessarily implies the death and removal of the occupied portion. But the determination and kind of blood, the kind of texture, and the nervous influence on the part, are each or all of them so modified as to have a tendency to death. The determination of blood may be more intense, or the kind of blood may be that which indicates the operation of some blood-poison, or at least a morbid condition of the blood, as in carbuncle and boil, phlegmonous erysipelas, sloughing bubo, and certain secondary syphilitic ulcerations, hospital gangrene, malignant pustule, malignant scarlatina, and small-pox. Unyielding textures are liable to gangrenous inflammation, owing apparently to strangulation of the capillary vessels, consequent on effusion which cannot be accommodated interstitially. Inflammation of any texture situated beneath one of this kind, as beneath a fascia or tendinous aponeurosis, has also a gangrenous tendency, and thus subpericranial inflammation is soon followed by gangrene and sloughing, exposing the scalp. But inflammation of a loose texture, if a comparatively avascular one, as the subcutaneous cellular tissue, is prone to sloughing, owing apparently to strangulation of the vessels, consequent on the ready accumulation of effusion, *e.g.*, in phlegmonous erysipelas. The influence of the nervous system is shown by the tendency to sloughing from injury to the spine. Mortification of the ankle has thence followed within twenty-four hours. (Brodie.) Ulceration of a part may supervene on injury of the nerves leading thereto; a central penetrating ulcer of the cornea was thus formed in consequence of destruction of the trunk of the trigeminal nerve by the pressure of a tumour near the pons varolii. (Paget.) And in another case, under my own observation, in the Royal Free Hospital, a similar ulcer of the left cornea followed an injury to the posterior part of the left side of the head. There was also considerable injection of the conjunctival vessels, and mucous secretion. These symptoms ceased, and the ulcer healed, leaving a slight opacity in the centre of the cornea. Other illustrative cases are on record.

The *Signs* of gangrenous inflammation are—acute burning pain,

instead of the throbbing of approaching suppuration. The redness deepens into purple, and thence to a livid hue, a change of colour due to stagnation of the blood in the dying part. The swelling, moreover, is peculiar, for here the textures are disintegrating and softening, macerated also by the effused fluid in which they are soaked. Hence a flabby softness is presented. Phlegmonous erysipelas, as it advances, well illustrates these signs of gangrenous inflammation.

Their diagnostic value is assured by their constancy and exclusiveness; they are never absent collectively in gangrene resulting from inflammation, nor present collectively in any other disease. Acute burning pain is, perhaps, the earliest or premonitory symptom.

From this condition of local disorganization the *constitutional* disorder at once commences. More insidious, its symptoms resemble those of pyæmia, although differing in degree. A wild, apprehensive look, with great restlessness, are conspicuous; the features and manner at length become more composed, and the face assumes a pallid hue. The skin over the whole body and the tunicæ conjunctivæ sometimes acquire a peculiar yellow colour. Utter prostration of mind and of muscular power gradually supervenes, and a quivering subsultus tendinum. The pulse beats very feebly, rapidly, and irregularly, feeling like a rough wire drawn under the finger. The secretions are soon perverted; the skin, at first hot and dry, is now bathed with a cold, clammy sweat; the urine, fetid and scanty, may be suppressed; a brown, rough, dry tongue is accompanied with nausea and a putrid diarrhœa. As the powers of organic and of animal life fail, involuntary excito-motions predominate; spasms and convulsions shake the moribund body, while coma ends in death.

This represents the course of an extreme case of gangrenous inflammation; but, short of it, various degrees of the same constitutional disturbance occur in different cases, and it represents also the constitutional disturbance which proceeds from spreading gangrene.

But the gangrene may cease to spread. The reddish-brown tint of the skin in advance of the dead part becomes brighter and more circumscribed. Shortly, a white raised line of demarcation is seen in the living skin, immediately adjoining the dead portion. Soon this line melts away into a groove by ulceration; extending deeper, it forms a fissure, and successively passing down through tissue after tissue at length converges, and completely detaches the whole of the dead parts. While the living organism is thus separating itself from the slough, adhesive inflammation precedes the line or fissure of ulceration in its length and depth, sealing the blood-vessels, so as effectually to exclude any further communication with the dead tissues, and prevent absorption of their *débris*. The typhoid type of fever passes off, and is exchanged for some degree of inflammatory fever, which accompanies the process of separation and detachment of slough.

The typhoid fever of gangrenous inflammation arises, apparently like hectic fever, from absorption of the disintegrating and dying or dead textures.

This conclusion rests on two species of evidence.

Firstly, the fever arises, and invariably, when mortification has advanced to sphacelus, *i.e.*, when dead tissues are present; and, moreover, when the veins, in some cases at least, are free to absorb.

Secondly, it begins to subside, and invariably, when sphacelus has

ceased to spread, *i.e.*, when the living organism is separating itself from the dead part, and when adhesive inflammation of the blood-vessels, corresponding to the line or fissure of separation, has intercepted any further communication through these vessels with the dead tissues.

Mortification, itself a destructive process, is, like ulceration, occasionally restorative, or reparative, by virtue of its purpose. It is so in the loosening and evulsion of a foreign body by sloughing of the part wherein it is embedded, the natural process whereby a thorn in the flesh is extricated. The spontaneous cure of aneurism, by sloughing, is another example; with many others of similar character.

Treatment of Inflammation, and its Consequences.—The earliest occasion for interference with inflammation is determined by considering its purpose with reference to the part affected. If it be the reparation of some loss of structure, or the construction of some new and useful mechanism in connection with such part, the process should be allowed to run its course, or when inadequate, it should be encouraged by maintaining or superinducing the requisite conditions.

Reparatively, inflammation is available in the healing of incised wounds or fractures, when the soft tissues or the bone are indisposed to unite by non-inflammatory adhesion. Other instances of this kind are cited at p. 77, and many additional illustrations will occur in practice.

Constructively, the plastic operation of lymph-deposit is available for the opening of an abscess safely from a great depth and by a dangerous route; and here also many analogous cases, additional to those noticed at pp. 77–8, are sure to come under the observation of the watchful clinical observer.

Supplemental to the restorative purpose of inflammation, as viewed productively, the destructive aspect of this process may have a similar character. Thus, ulceration forms an opening for the discharge of superfluous organizable material—pus; and mortification, by sloughing, is useful in loosening and facilitating the evulsion of a foreign body. Obviously in any such case, if interference be necessary, the destruction of textures can be turned to good surgical account.

Whenever the purpose of inflammation is neither reparative, constructive, nor usefully destructive, the process should forthwith be arrested, or subsequently conducted to a favourable issue.

In accordance with the pathology and causes of inflammation, the following are the general indications of treatment to be observed:—

(1.) The removal of any exciting cause or causes in operation is the fundamental rule of treatment; bearing more especially on the arrest of inflammation. The causes alluded to comprise the various kinds of irritant matters—mechanical, chemical, and vital—that were enumerated among the "external" causes of inflammation (p. 70); moreover, any constituent of the organism which has become a foreign body, and morbid products, which are more apt to assume that character. They are the "internal" exciting causes of inflammation (p. 71). The significance of their operation, and the efficacy of their removal, as causes of irritation, are well illustrated in the every-day practice of Surgery. Blood, extravasated and decomposing, is a poison; its evacuation is followed by the subsidence of inflammation and constitutional disturbance. A slough of soft textures contami-

nates; its withdrawal is similarly beneficial. The extraction of a piece of dead bone will arrest a discharge of pus which had continued for weeks, months, or years, and had reduced the patient to the brink of the grave. Excretions are obnoxious when decomposed, and powerfully irritant to parts not intended by nature for their reception; as urine extravasated into the cellular texture of the scrotum. And the evacuation of excretions under these circumstances arrests the concurrent inflammation. Hence the efficacy of free incisions in the scrotum in the case supposed. Of morbid products, a calculus in the kidney provokes nephritis; this inflammation ceases when the stone passes down the ureter into the bladder, and is succeeded by cystitis, which in its turn subsides when the foreign body is removed by lithotomy or lithotrity. These examples will suffice to enforce the general rule of treatment.

Whenever the exciting cause in operation—whether externally or internally—is removable, the process of inflammation not unfrequently ceases with its removal. Fortunately also the fulfilment of this indication meets the requirements of an already large class of cases, and an increasing class as our knowledge and detection of causes becomes yet more early and exact. It is thus that inflammation of local origin may often be arrested, as compared with that which depends on constitutional causes.

In all other cases the process continues and runs its course to structural results, if unopposed. The treatment required is no longer preventive only, but counteractive also.

(2.) Removal, therefore, of (*a*) the pathological conditions or elements which, co-operating, constitute inflammation; and of (*b*) its local consequences with their accompanying constitutional disorders;—inflammatory fever, hectic, and gangrenous typhoid fevers.

(*a.*) The conditions to be overruled by appropriate remedial measures comprise—accelerated textural productiveness, and accelerated textural waste or destruction of texture; the determination of arterial blood, and any morbid quality of the blood supplied to the inflamed texture or organ; also perversions of the nervous influence.

Experience has established the remedial efficacy of certain measures, both local and constitutional, and which constitute the "antiphlogistic" treatment. This term having been long since recognized in practice, it may be conveniently retained without implying any theory as to the *modus operandi* of the agents employed.

Local antiphlogistic measures consist in rest of the part, and the application of cold, heat, or warmth, with moisture, as in the common bread-and-water poultice or moist spongio-piline epithem; in blood-letting by leeches or scarification, an elevated position of the part inflamed; incisions, sufficient to relieve tension; antiseptic dressings; blisters, setons, issues; caustics, as caustic-potash, mineral acids, iodine, burning heat or the actual cautery, and other strong irritants; astringents, friction, pressure.

Constitutional or systemic measures include — blood-letting by venesection, purgatives, diaphoretics, diuretics, starvation and the antiphlogistic *régime*, antimony, opium, mercury, wine, brandy, ammonia, and other stimulants; cinchona bark, the mineral acids, and other tonics; cod-liver oil, nutritious diet.

Taking this list of remedial agents, some are of the most opposite character, but they may all be used appropriately, in the course of inflammation generally, and in the order enumerated.

Rest.—This element of remedial treatment has a most important relation, local and constitutional. Rest of the part undergoing inflammation will tend to arrest that process, by suspending the exercise of function, and the consequent nutritive changes, in the part thus affected; rest of body and mind is restorative, by suspending, in some degree, the functional activity of the nervous, the muscular, and the vascular systems, which are principally engaged in febrile disturbance, and the excitement of which reacts unfavourably on the inflamed part. Thus, an inflamed hand should be kept at rest by placing it in a sling, or supported on a pillow, or more absolute rest may be secured by the mechanical contrivance of a splint; while the repose of recumbency on a couch, the cessation of any mental exertion or emotional excitement, and the exclusion of talkative friends, of noise and light, or other impression on the senses—in short, of every source of disturbance to the patient—constitute that general quietude which will be most favourable to recovery.

Cold is more efficacious in the early treatment of inflammation, and as affecting external parts of the body. It may be applied, according to the degree of cold required, by means of cold water or ice, or by an evaporating lotion of spirits of wine and water in various proportions. Lead lotion—the liquor plumbi diacetatis, a drachm or more to eight ounces of water—is another refrigerant, but far less serviceable. The application of cold externally will even reach an internal organ, as the brain in meningitis, through the interposed scalp and cranium; but in all such cases the more intense cold of pounded ice in a bladder is necessary to produce a beneficial effect. Esmarch uses an india-rubber bag, which certainly looks better in private practice. To some internal organs cold can be applied directly, as to the stomach in gastritis, by swallowing bits of ice.

The leading fact to be observed in every case is, that refrigeration should be continuous and uniform. This twofold requirement is best fulfilled by some form of self-acting irrigator. A skein of cotton pendant from a bottle of cold water suspended over the part will supply a constant dribbling stream, and thus answer the purpose very well. Its efficiency is witnessed in preventing or arresting inflammation of the large joints.

Heat, moderate, with *moisture*, is preferable in those cases where cold is uncomfortable to the part, or occasions any shivering sensation. Moist warmth is more advantageous also when inflammation is established, the efficacy of cold as a textural depressor being restricted rather to incipient inflammation. Warmth and moisture are conveniently applied in the shape of a light, soft bread-and-water or linseed-meal poultice; or by means of spongio-piline soaked in warm water. The latter surpasses any kind of poultice, which is apt to dry, thus becoming an irritant, and is uncleanly. Spongio-piline is even more retentive of moisture than an equal substance of flannel, and more suitable, therefore, as an epithem.

Blood-letting locally is advantageous whenever it appears desirable to make a sudden, considerable, and direct impression on an inflamed part, as the eye in iritis. Leeches, scarification, or cupping are avail-

able for this purpose. Leeches can be applied to a part which is inaccessible to the cupping-glass, as the os uteri. But the drawing action of a cupping-glass, the pressure of the atmosphere being removed, penetrates to a greater depth than the abstraction of blood by leeches. Hence cupping is more suitable for inflammation of internal organs, as the kidneys when inflamed.

In employing either mode of topical blood-letting, it should be remembered that hæmorrhage may continue for some time after a leech-bite or cupping. An average-sized leech, when fully distended and ready to drop off, holds about a drachm and a half of blood, and the amount drawn by a cupping-glass can be watched and measured ; but the quantity which flows subsequently should always be taken into account and allowed for, more especially with regard to leeches, the after-hæmorrhage from which is more uncertain—by fomentation amounting to half an ounce, or far more, even spontaneously. A single leech has thus proved fatal to an infant. The hæmorrhage is, perhaps, best arrested by touching the little triangular punctured wound firmly with nitrate of silver ; or, by transfixing the bite with a fine needle, and applying a figure of eight ligature.

Dry cupping, or the application of an exhausted cupping-glass without previously using the scarificator, is a method of drawing blood to the surface, without abstracting it from the mass in circulation ; yet it may be questionable whether the blood thereby rendered stagnant, is not spoilt for the purpose of any returning circulation. The corpuscles are damaged or destroyed, and this change will, of course, be more likely to occur, the more frequently the cupping-glass is re-applied to the same part ; so that the blood might as well be withdrawn from the body, as left partially extravasated with its corpuscles broken up.

It has been proposed to stop the *afflux* of blood to an inflamed part, either by ligature or compression of the main artery ; a mode of reducing the local circulation which may prove even more effectual than the topical abstraction of blood. Ligature was thus practised by Professor Campbell, at the Georgia Hospital, during the American war ; and his experience led him to this conclusion—that in all cases of destructive inflammation, especially from injury, in the leg or arm, ligature of the artery supplying the affected part should be tried, whenever the state of the patient will admit of this procedure, before resorting to amputation. Compression, recommended by Professor Vanzetti of Padua, has been practised with success, not only by himself, but also in Paris, and in Prague, and in a case by the late Mr. C. H. Moore.

Position.—An elevated position of an inflamed part is equivalent to the local abstraction of blood. The determination of blood becomes diminished, and the return of blood facilitated ; whereby the quantity in the part is greatly reduced. Elevation thus offers a resource which is a good substitute for, or a useful adjunct to, local blood-letting. Its efficacy is witnessed in the treatment of inflammation affecting different parts of the lower extremity ; as in compound fracture of the leg, dislocation or disease of the knee-joint, and other morbid conditions. The relaxation of any muscles which, subject to spasm, would disturb the part inflamed, is another important consideration. This must be affected by *posture.*

Incisions may be resorted to for the relief of tension ; this being

caused partly by distension of the blood-vessels in the part inflamed, but principally by the serum effused. The incisions should be made in extent and depth according as either condition of tension predominates. In chemosis, the sub-conjunctival collection of serum suggests the kind of incision necessary. In glossitis, vascular distension is relieved by scarification over the upper surface of the tongue, rather than by one free incision. In phlegmonous erysipelas, both sources of tension are relieved by incisions in different parts of the skin, as the chief seat of vascular distension, and extending down to the subcellular texture, which is engorged with serum. In all cases, however, the requisite length and depth of incisions must be determined practically, by their effect in relieving tension. A poultice is applied, but *after* the cessation of hemorrhage, lest more blood be lost than would be desirable. If the bleeding return, the poultice must be removed, and strips of dry lint placed in the bottom of each incision up to the surface, and a light pad over all, retained by a bandage; with the limb or part in a elevated position. After a few hours, the bandage and pad may be removed, and a poultice re-applied, over the strips of lint, which should not be withdrawn until they separate with suppuration.

Incisions for the discharge of pus and slough will be considered in a subsequent part of the treatment of inflammation.

Antiseptic dressings are eligible in the treatment of inflammation, only when attended with an open surface. Their nature and modes of application are explained in the treatment of Wounds.

Irritants.—Blisters, in the form of cantharides plaster or the blistering fluid; rubefacients, as the mustard poultice; setons, issues; caustics, as nitrate of silver, potass-fusa, the mineral acids, iodine, mercury, tartar-emetic, croton oil, burning heat or the actual cautery, and other strong irritants, are remedial measures of more or less value in *chronic* forms of inflammation. Their intensity of action varies, but their kind of action is said to be counter-irritant or derivative from the inflamed part, by exciting inflammation in the neighbourhood of that part. This may be true in some cases. In other cases irritants have the opposite effect—they increase the inflammation in the part itself; either bringing it to a termination by resolution, or by promoting effusion and hurrying on the process to suppuration.

According to the object in view, therefore, we should apply any such agent more or less nearly in relation to the part inflamed, and be guided in our choice of one or other by regard to the intensity of its operation; observing also that the local irritation do not increase the febrile disturbance.

A *seton* consists of a skein of silk, worsted, cotton, or hemp thread, which is attached to the eye of a needle, three or four inches long, and a quarter of an inch in breadth. The integument is pinched up between the thumb and forefinger, and the needle passed through, carrying the seton-skein after it; the needle is then cut off, leaving the lash of threads in the subcutaneous track, and either end hanging out. Inflammation is soon excited, with suppuration; and this counter-irritation and derivative discharge are established for so long a period as it may be desirable to allow the foreign body to remain. If the needle be not at hand, the seton may be passed by means of a common probe; a bistoury having been passed through the fold of integument, the armed probe is slid along the flat of the blade.

An *issue* is applied in the following manner:—Take a piece of adhesive plaster, say three inches square, and having cut a round central aperture, the size of a sixpence, fix it upon the part where the issue is to be formed. Then place a small piece of caustic potash, the size of a pea, in the central hole of the shield, and cover over with another piece of plaster. The severe burning pain of cauterization passes off in the course of a few hours, when the plasters may be removed; a black eschar is seen, which should be poulticed for a few days, until it comes away, leaving an ulcer in the form of a hole. To maintain the discharge, insert a pea or a glass bead, which may be smeared occasionally with savine ointment.

A few examples will illustrate the remedial value of this class of agents in inflammation. Blistering the skin is very serviceable in chronic and deep-seated inflammation of the bones and joints. In chronic arthritis, the bulky ends of bone which form the knee-joint and their articular cartilages, are most advantageously influenced by the action of blisters, placed above or below the joint. A seton or issue, which produces a constant discharge of pus from the neighbourhood of the vertebræ, is often of signal service in caries of the bodies of these bones. When applied to the nape of the neck, the same beneficial effect is witnessed in chronic meningeal inflammation of the brain. Of caustics, the potass-fusa is sometimes useful in similar cases, but it is comparatively seldom employed. I rarely use this kind of caustic; and, indeed, it seems to be going out of fashion. Nitrate of silver, lunar caustic, promotes the resolution of a whitlow, a bunion, a hordeolum or sty in the margin of the eyelid, and such like intractable conditions of inflammation. Of the mineral acids, as caustic appliances, nitric acid, undiluted, is of great service for converting phagedænic ulceration into inflammation with healing granulations; but this is scarcely an appropriate illustration as to the treatment of inflammation itself. Iodine "paint," consisting of equal parts of iodine and of iodide of potassium, to two parts of rectified spirit, and four parts of water, is a strong irritant, of considerable value in removing the effusion and induration attending chronic inflammation generally. Various stimulating embrocations also, as camphor and ammonia, with olive oil, are thus used. The actual cautery may be resorted to, with marked benefit, occasionally, in cases of deep-seated and chronic inflammation affecting the joints and bones, and especially the vertebræ. Thus also the burning-moxa was formerly in some repute. Placed over the spine, and allowed to burn down, it produces a circular slough of skin about the size of a shilling or half-crown. Several moxæ were sometimes applied in a row. But the remedial efficacy of such a powerful counter-irritant measure as even one moxa, is very doubtful; while the severe and continued pain is a decided disadvantage, and more so in virtue of its tendency to aggravate inflammatory fever.

This consideration, indeed, restricts the use of the more powerful kinds of counter-irritants. Unlike the pain caused by the clean cut of a knife in most surgical operations, the pain induced by strong cauterization is felt when the influence of chloroform has ceased, although the part itself may be killed outright. It deserves full trial, observes Mr. Simon, whether every intense, and consequently painful, form of counter-irritation might not be superseded by the

employment of other means, less intense, but more extensively applied; whether, for instance, ten inches of poultice may not be equivalent to four inches of blister, or to one inch of issue. In respect to thoracic inflammation, for example, where blistering is employed as a matter of routine practice, the unsurpassed clinical authority of Professor Skoda pronounces such treatment to be always useless, sometimes hurtful.

Astringents prove serviceable in a congestive, and often chronic state of inflammation; the capillary vessels being distended and obstructed. A solution of nitrate of silver, or the sulphate of zinc —five or ten grains to the ounce of distilled water—may then be used with great benefit, as in congestive conjunctivitis; and the relief afforded by an alum gargle in relaxed sore-throat, is another illustration of astringent applications. Cold *douches* probably act in like manner, by constringing the weakened and overloaded vessels of a part affected with chronic inflammation; as the joints, for example.

Friction offers another resource, in a similar state of inflammation; the act of rubbing with the hand, or shampooing, not only tending to unload the vessels, but also operating as a stimulant, to promote the circulation in the part. Hence friction may be aided by the use of some stimulating liniment or embrocation, as of camphor and olive oil.

Pressure has the beneficial effect of supporting the vessels when in a relaxed state; but this means may also be combined with a stimulant application. Thus, the support of a bandage, or of simple strapping with soap-plaster spread on leather, may be exchanged for the emplastrum ammoniaci cum hydrargyro; and either mode of treatment is often very efficacious in chronic inflammatory affections of the joints, breast, or testicle.

Constitutional Remedial Measures.—*Systemic blood-letting*, by venesection. This mode of depletion has fallen nearly into disuse, in the treatment of inflammation.

The explanation of this change of practice on the part of the Profession generally, is referable to two entirely different views, each having its partisans. According to one school, so to speak, the human constitution has itself undergone a great change in the loss of vital power, whereby febrile symptoms have altered from an inflammatory to a typhoid character. The late Dr. Alison was the champion of this doctrine. On the other hand, it is contended that the principle on which blood-letting had hitherto been practised is opposed to Pathology, and that our more advanced knowledge of this science has led to its abandonment. This explanation is offered and ably advocated by Dr. J. H. Bennett.

Assuredly the change of practice has taken place, and experience sanctions its propriety in most cases. As to its interpretation; probably in regard to this, as to many vexed questions, both parties are partly right, and partly wrong.

But it is not only in the present as compared with former practice, in one period as compared with another, that differences of opinion have prevailed respecting the remedial value of general bleeding in inflammation; it is no less remarkable, as Mr. Simon observes, that contemporaries living under the same sky, and practising in the same

year on the same disease, have waged controversy on this subject; and not unfrequently it has seemed probable that medical juries, inquesting any given dead patient, would divide in equal numbers, whether much bleeding or little bleeding had killed the man.

In explanation of this anomaly the same author urges that, practically, all impartial observers seem now to agree, that while there are inflammations which bleeding can relieve, yet there are also inflammations which every act of depletion, instead of diminishing, will increase. And the obvious inference from this fact is one which, certainly, the pathology of inflammation would indicate—that the therapeutical value of blood-letting does not so much consist in its directly controlling inflammatory excitement, as in its controlling some condition, which may or may not be concomitant.

What, then, is this condition? Reserving for a moment that which Mr. Simon suggests, I would first notice another.

Forcible contractile action of the heart, with a strong pulse, undoubtedly maintains the local determination of blood; although this latter may be aided by the accelerated nutritive changes of the part itself, using up the plasma supplied, and thereby continuously eliciting exudation from the capillary vessels.

General blood-letting, by venesection, powerfully relieves the action of the heart, even to syncope. But, with inflammatory fever, the system is more tolerant of loss of blood than in health, or other diseases. This increased tolerance was first clearly shown by Dr. Marshall Hall, the results of whose investigations are given in the following table, which represents, as compared with health, the mean quantity lost before incipient syncope is induced, the patient being in the sitting or the erect posture:—

1. Healthy Tolerance:	
This depends on the age, sex, strength, etc., and on the degree of thickness of the parietes of the heart; but it is about	℥ xv.
2. Increased Tolerance:	
Congestion of the brain	℥ xl.—l.
Inflammation of serous membranes . . .	
Inflammation of synovial membranes . . .	℥ xxx.—xl.
Inflammation of fibrous membranes . . .	
Inflammation of the parenchyma of organs—brain, lung, liver, mamma, etc. . . .	℥ xxx.
Inflammation of skin and mucous membranes, erysipelas, bronchitis, dysentery . . .	℥ xvi.
3. Diminished Tolerance:	
Fevers—eruptive and others	℥ xi.—xiv.
Delirium tremens, and puerperal delirium . .	℥ x.—xii.
Laceration or concussion of the brain . .	
Accidents, before the establishment of inflammation	℥ viii.—x.
Intestinal irritation	
Dyspepsia, chlorosis	℥ viii.
Cholera	℥ vi.

The condition to which Mr. Simon refers as deserving especial

notice, is that state of the vascular system which, often designated "vascular tension," is characterized by a hard pulse.

Both these conditions—forcible action of the heart and vascular tension—are alike diminished by general bleeding; the pulse becoming weaker, slower, perhaps more regular, and softer.

The propriety of having recourse to this reducing measure should therefore be determined and regulated by reference to the state of the general circulation, as indicated by the characters of the pulse in respect to its force and hardness. But the necessity for blood-letting is proportionate also to the physiological importance of the organ affected, which might otherwise be permanently damaged by the structural results of inflammation; and the urgency on this ground will be indicated by the functional disturbance which the organ itself suffers, and induces by its functional relation to other organs. These conditions of organic significance are not accompanied with a corresponding tolerance of blood-letting. For example, they co-exist in pneumonia, especially double pneumonia; the lungs being highly important organs functionally, dyspnœa, and general functional disturbance thence arises. Yet in this disease the tolerance of blood-letting is thirty ounces, as shown by the table, or only double that of health, and less by twenty ounces than that of the highest range in the list.

The effects of blood-letting are more than momentary. This should always be remembered in considering the necessity for producing a powerful and persistent impression on the general circulation. Such impression can be made in either of two ways; the one or the other having a salutary tendency, according to the previous duration of the inflammation.

Recent inflammation may be arrested by the loss of a moderate quantity of blood, suddenly—*i.e.*, through a large orifice or from both arms at the same time, and the patient being placed in the sitting posture, so as to induce syncope.

Inflammation of a few days' duration will be more surely brought to a termination by the loss of a larger quantity of blood, gradually; the bandage above the orifice in the vein being loosened, and the patient placed in the recumbent position to avert the tendency to syncope. Or venesection may be repeated from time to time, according to the symptoms; thereby renewing and further maintaining the impression originally made on the circulation.

The advantage of gradual over sudden loss of blood, in inflammation of some duration, is evinced by the fact that, if the first impression be thus maintained, it is found unnecessary to repeat it.

Local blood-letting, by means of leeches, or cupping, will prove sufficient subsequently, in most cases; and advantageously so, by directly affecting the inflamed part without powerfully and persistently influencing the system. And it should never be forgotten, that the permanency of systemic impression is directly proportionate to the quantity of blood lost. Nutrition is reduced throughout the body, and any process of reparation may fail. Probably the vital injury of excessive blood-letting or of such hæmorrhage accidentally, is never quite recovered from.

Venesection or *Phlebotomy* might be effected by opening any vein of sufficient size to admit of a free flow of blood; but the vein usually

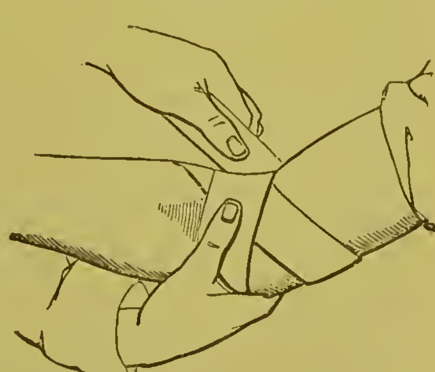
selected is one at the bend of the elbow,—the median basilic in particular; or the external jugular in the neck, will be preferable in exceptional cases.

At the *bend* of the *elbow*, venesection may be performed, with certain precautions, as follows:—The *median basilic* vein having been selected, on account of its large size, superficial situation, and fixed position by the aponeurosis between it and the brachial artery; a spot is chosen just above or below where the vein crosses upwards over that vessel. A roller bandage is drawn round the arm above the elbow, to obstruct the current of blood; in order that the vein shall be made more prominent by distension, and that, when opened, the stream of blood shall be free and uninterrupted. (Fig. 26.) Then, compressing the vein with the thumb of the left hand, just below where the puncture is to be made, so as to steady the vessel, the blade of the bleeding-lancet

Fig. 26.

being held betwixt the thumb and forefinger of the right hand, the point of the instrument is thrust into the vein, until resistance ceases or a drop of blood escapes, when, by a slight upward movement of the blade, a small oblique incision in the vessel is completed; observing also to divide the skin somewhat more extensively, that the opening in the integument shall be larger than that in the vein. The stream of blood should be received into a vessel, shallow or deep, according to the observations which may be desirable with reference to its coagulation and the formation of the buffy coat. When the blood-stream becomes sluggish, the flow may be accelerated by desiring the patient to grasp some substance, as the lancet case, and work his fingers; whereby the muscles of the forearm compress the deep veins, and thus produce an increased flow through the superficial veins. The quantity of blood to be drawn off will be regulated by the considerations already explained. Then the stream is stopped by placing the thumb on the bleeding orifice, and removing the ligature from above the elbow. A compress of lint is slid on to the wound, and retained in position by a figure

Fig. 27.



of eight bandage. (Fig. 27.) This is done by carrying the roller round the arm below the elbow, thence upward across the pad, and round the arm above the elbow, down over the pad again to the first turn. The arm being placed in a bent position, should be kept at rest, in a sling, for a few days.

In performing venesection, certain *accidents* are liable to happen, unless the precautions already noticed be observed. *Thrombus*, in the form of a collection of blood within the cellular texture around the vein, would arise by any displacement of the vein from want of compression in the act of puncture, so that the cutaneous and venous orifices do not correspond; or from a too limited cutaneous incision, thus also retaining the blood and causing a lodgment. *Aneurismal varix*, or *varicose aneurism*, would occur, or result, from thrusting the lancet too deeply, so as to transfix the vein and enter the artery, or from any sudden start of the patient. Hence the importance of selecting a spot for puncture, above or below where the vein obliquely crosses upwards over the artery. To avoid any risk of wounding the artery, some surgeons have preferred opening the median cephalic vein. A tight bandage after venesection has been known to induce gangrene of the forearm; and as the bandage becomes tightened when the arm is bent, allowance for this should be made in adjusting the turns of the roller.

The *external jugular vein* may be chosen for venesection in certain exceptional cases of inflammation, as in meningitis or encephalitis; or in non-inflammatory affections of the brain, as apoplectic compression. It will be convenient to here notice this method of venesection. The spot selected for puncture is where the vein lies on the sterno-mastoid muscle, the vessel being there more superficial and fixed than in any part of its course. Compression is made with the thumb just below the point for opening the vein, in order to give some prominence to the vessel by distension, and, moreover, prevent the entrance of air, a liability which would almost inevitably have a fatal result. The incision should be made obliquely, but across the direction of the fibres of the platysma myoides, which, by their contraction, will thus make the wound gape and secure a fair opening. Otherwise, if the incision were made parallel to the fibres of the platysma, scarcely any blood would flow, and extravasation taking place, that would give rise to thrombus. When a sufficient quantity of blood has been abstracted, the thumb is placed over the opening, and a pad of lint slid on to the spot, being there retained by cross strips of adhesive plaster; aided by a bandage, if necessary, carried across the pad, and round under the armpit of the opposite side.

Arteriotomy may be performed as an occasional substitute for phlebotomy, and principally in affections of the head or of the eye. The temporal artery is the vessel selected, and its anterior branch, as being superficial, and well supported by the temporal fascia. On compressing the vessel with the thumb on the distal side of the intended aperture, it becomes prominent, and then with the lancet an oblique opening should be made. The blood may be received into an unexhausted cupping-glass; an exhausted receiver would stop the stream by pressure of the circumference of the glass across the vessel. The flow of blood can be arrested by completely dividing the artery, the cut extremities retracting and contracting. If necessary, the ends

may be secured by ligature, torsion, or acupressure. A lint-pad is, however, usually applied; and this answers best, as the vessel rests on the fascia and temporal bone, the temporal muscle only intervening. The pad is fixed firmly in position by a double roller bandage, carried round the head, twisted over the compress, and fastened under the chin.

Purgatives not only remove fæculent matter, which would otherwise be a source of irritation affecting also a large extent of intestinal mucous membrane, but their operation is depletory by inducing the discharge of serum from the blood. Purgatives are, therefore, a useful adjunct to, or even a substitute for, general blood-letting, in relieving vascular tension. Different kinds of purgatives appear to act on different portions of the intestinal tract; and hence a combination of these medicines may prove more efficient than any one alone. Salts and senna, jalap and rhubarb, are familiar examples of such combinations. It would be very desirable to acquire more extensive and exact knowledge respecting the action of purgatives for this purpose.

But they probably have also different selective powers, in promoting the discharge of different constituents of the blood, and various effete or noxious matters; thus affecting the quality as well as reducing the quantity of the blood in circulation. Here, more especially, further clinical observation would be highly desirable.

Besides removing irritant matter, and having a depletory and an excretory operation, purgatives are said to have a derivative action, apparently by inducing hyperæmia of the intestinal mucous membrane. In this way they are supposed to antagonize inflammation of the brain, for example. But it is a kind of action which prohibits the continued use of purgatives, lest intestinal inflammation be superinduced.

The purgative operation of mercury is referable to its agency in promoting the secretion of bile,—itself a natural purgative. Besides, however, having this effect, the "cholagogue" action produced by larger doses of mercury is equivalent to general blood-letting as a depletory, and superior as an excretory, remedy; for the copious spinach-like evacuations produced are equally effectual in reducing vascular tension, and are specially excrementitious, without unnecessarily diminishing the quantity of blood in circulation. Calomel, in doses of five, ten, or twenty grains, and repeated as occasion may require, is perhaps the best cholagogue.

The action of mercury on the liver as a secreting and excreting organ, suggests a general inquiry respecting the action of other purgatives, specially on the glandular apparatus of, or associated with, the gastro-intestinal organs. What medicines specially affect the secretion of the pancreas; what, with regard to the glands of the gastro-intestinal mucous membrane, namely, the tubular, the cardiac, and the lenticular glands of the stomach; the glands of Brunner, the crypts of Lieberkuehn, and Peyer's glands, of the small intestine; and the innumerable follicles of the large intestine?

Diaphoretics and *diuretics*, medicinal agents which increase or alter the secretions of the skin and kidneys, respectively, are purgatives in their way. They are depletory, excretory, and derivative. Such is the acetate of potash, a diaphoretic, and the nitrate of potash, a diuretic. Little or nothing is known of these, and similar medicines, in their

intimate relation to inflammatory fever. Experience alone sanctions their use. Their administration constitutes what is more particularly designated "febrifuge" treatment. A liberal allowance of water, soda-water, or other bland fluid, seems to favour the excretory operation of these medicines; probably by diluting, and, as it were, washing away effete matters from the system. A cool, fresh atmosphere around the patient is a most important adjunct to febrifuge treatment, in carrying off the heat, and exerementitious emanations of febrility. Hence, the antiphlogistic value of a well-ventilated apartment, the amount of clothing or bed-covering being regulated by the diaphoretic treatment; while cleanliness must be attended to, as subservient to atmospheric purity, and freedom from any irritation to an externally inflamed part.

Starvation is another kind of depletion, by withholding the supply of nourishment. And if this were all that the term suggests physiologically, its significance therapeutically in relation to pathology, would be very simple. But starvation has reference to many differently constituted textures; each undergoing its own nutritive changes, and having its own food requirements. Consequently, the starvation of any one kind of texture, and kindred textures, is physiologically possible without, at least proportionately, depriving others of their food. Thus, the albuminoid textures, of which muscle is the type, might be starved, apart from the gelatinous, as skin and mucous membrane; and these again apart from osseous texture. The various artificial preparations of food have not, however, hitherto reached this desideratum of composition, for the purposes of therapeutic treatment, yet it would bear very directly on inflammation,—accelerated nutrition,—as affecting different organs and their component textures. The "antiphlogistic regimen" is rather a negative than a positive regimen. Dietetically, it consists in abstinence from animal food and stimulating drinks, and in the moderate use of bland fluids, as barley-water, gruel, arrow-root. But it also implies the exclusion of all surrounding circumstances of excitement to mind or body. A cool and well-ventilated apartment, an easy bed, exclusion of light and noise, the prohibition of conversation, of the constant presence and attention of friends, and the banishment if possible of care; such are the principal features of this regimen.

Antimony, as an internal remedy, most nearly resembles general blood-letting. After a dose of, say, half a grain, repeated or increased to one or even two grains, every three hours, until vomiting occurs, the effect on the circulation and secretions are very marked. At first, the pulse becoming more rapid and feeble, it dwindles down to a fine thread. Then, vomiting having occurred, the pulse loses its frequency, and perhaps regains its force, but acquires a peculiarly full and soft character; showing that vascular tension is overcome or relieved. Simultaneously, perspiration and the secretion of urine are notably increased; and liquid evacuations from the bowels not unfrequently accompany this relaxation. The muscles also are flaccid and powerless. In short, the whole muscular system, voluntary and vascular, is relaxed; and a flux or flow takes place from various secreting organs, which further reduces the vascular tension. Any local inflammation is thus materially diminished.

A full dose of tartarized antimony having this result, similar

effects, though in a less marked degree, and without the distress of vomiting, may be produced by smaller doses. Fortunately, however, vomiting soon ceases, while the beneficial influence continues with the full administration of the medicine; or this symptom may be controlled by administering it in the form of a saline draught with four or five minims of diluted hydrocyanic acid. The action of this remedy is most salutary when even nausea is not induced.

Antimony will be most advantageously prescribed after general blood-letting to maintain its effects, and in proportion as the vascular tension, indicated by hardness of the pulse, continues. But either resource may be considered a substitute for the other; and experience gives the preference to antimony, generally. It is found to be most effectual in pneumonia, orchitis, and inflammation of other unyielding textures; less so with regard to serous membranes; and it is contra-indicated in enteritis.

Opium is of signal service in the treatment of inflammation. It seems to act partly like antimony and blood-letting by overcoming vascular tension, but opium has the advantage of also subduing nervous excitement. Its administration is, therefore, most appropriate when this is the predominant element in inflammatory fever; or when, excitement of the circulation declining, that of the nervous system with general weakness becomes prominent. It is thus that opium proves so beneficial after severe injuries or surgical operations; where shock is followed by excessive reaction, or prostration with excitement prevails over or outlasts inflammatory fever.

In some cases, opium acts specially on the part injured or operated on, by subduing muscular movements, voluntary or involuntary, as by paralyzing the peristaltic movements of the intestine after the operation for strangulated hernia. It seems also to depress the textural activity of the inflamed part, and to influence, in some way, favourably, inflammation having an ulcerative or gangrenous tendency.

The chief disadvantages attending the use of opium are—the sickness it is apt to occasion at first, and constipation by its more continued use. The latter can be controlled or prevented by our next remedial measure, prescribed in combination with the opium.

Mercury counteracts the constipating tendency of opium, and this, in its turn, overrules the aperient action of mercury; either medicine checking the intestinal influence of the other. The combination generally employed is calomel and opium; in the proportion of from one grain to five of the former, with a quarter of a grain to one grain of the latter, given as a pill every four hours or so.

But does the continued administration of this familiar formula produce any remedial effect, through the *systemic* influence of mercury? This is debatable ground. Unquestionably, mercury can be introduced into the system—meaning thereby the blood in circulation—and it then produces peculiar symptoms; the gums becoming red, spongy, and tender, the breath having a peculiar fœtor, and a metallic taste being experienced like that of copper in the mouth. The salivary glands under the tongue and at the angle of the jaw become somewhat swollen and painful, and the secretion of saliva is increased. This associated group of symptoms, constituting "salivation" or ptyalism, announces that the system is under the influence of mercury. Mercurial infection, or "mercurialism," as it is called, is in fact attested

by the supervention of certain symptoms; just as the introduction of the syphilitic virus, for example, is followed, in the course of time, by enlargement and ulceration of the tonsils, some definite skin eruption, and perhaps iritis; symptoms declaring the syphilitic infection to have taken place.

So far, then, there are certain effects specially due to the systemic influence of mercury.

Formerly also, and until recently, it was unanimously held that the same influence prevented or retarded the effusion of fibrin, and promoted its absorption. That "the constitutional action of mercury opposes the organizing efforts of inflammation," is the somewhat equivalent expression of Mr. Simon. Does this represent the remedial virtue of mercury in the systemic or constitutional treatment of inflammation? A good illustration of such influence was supposed to be, the visible disappearance of lymph in iritis, apparently under the operation of mercurialism.

Long as this therapeutic theory prevailed, and practice accordingly, there are reasons for doubting the accuracy of the one, and the efficacy of the other. That mercury exercises some kind of influence over nutrition, there can be no doubt; but it is questionable how far the natural course of inflammation, having induced the effusion of fibrin, may itself tend to absorption, apart from the co-operation of mercury. Mr. Simon limits the agency of mercury by the following qualifications: that, "if mercurial cachexia in its lesser degrees, and independently of the purging which may attend it, has a real effect on inflammatory products, this effect probably relates only to such products as are not organized, and perhaps is nothing more than the giving of some special assistance to the dissolution and removal of fibrin."

Further clinical investigation is needed to determine the question at issue.

Assuming the systemic influence of mercury upon inflammation, its remedial operation can be insured only by employing it in a certain class of cases, and with certain precautions.

Both these practical requisites are generalized by Sir Thomas Watson, thus:—

"In common adhesive inflammation, whether of the serous or areolar tissues; whenever, in fact, you have reason to think that coagulable lymph is effused, and mischief is likely to result from its presence, then you may expect benefit from the proper administration of mercury; as an auxiliary, however, to blood-letting, when blood-letting is indicated, not as a substitute for it. . . . Previous blood-letting renders the body more readily susceptible of the influence of mercury; and the operation of the mercury comes in aid of the salutary effects of the abstraction of blood. The two remedies accomplish by their joint power what neither of them might be able to accomplish singly.

"On the other hand, mercury is likely to be hurtful in those forms of disease, where the morbid action approximates to its own action; in cases of erysipelatous inflammation having a disposition to gangrene; in scrofulous diseases; in inflammatory complaints attended with general debility, and an irritable condition of the nervous system, or a manifest tendency to take on a low and typhus-like character." On behalf of the scrofulous diathesis, it is added that moderate sali-

vation may prove salutary during an attack of common inflammation, and as surely injurious if the inflammation be scrofulous.

"When we have to contend with acute inflammation, and desire to prevent or arrest the deposition of coagulable lymph, our object is, after such bleeding as may have been proper, to bring the system as speedily as possible under the influence of mercury.

"We know that the whole system has been brought under the specific influence of mercury, as soon as its effects become even slightly perceptible in the gums and breath of the patient; and in adults we cannot be sure of it before. These symptoms are enough; you need not in general look for any more decided affection of the mouth, such as ulceration of the gums, swelling of the glands beneath the jaw and the tongue, and a profuse flow of saliva. . . . . All that is requisite is, that the gums should become distinctly tender, and that the mercurial fœtor should be unequivocally manifest, and that these symptoms should be kept up for a certain time. Now this is best effected, usually, by giving some form of mercury in equal and repeated doses by the mouth. For urgent cases, calomel is the best form in which it can be administered; two or three grains given every four or six hours, will generally suffice to touch the gums in the course of thirty-six or forty-eight hours. If it act as a purgative, its specific effect upon the whole system will be postponed by that circumstance; and it then becomes expedient to combine it with just so much opium as will prevent it passing off by the bowels. A quarter of a grain of opium with two grains of calomel, or a third of a grain of opium with three or four grains of calomel, will generally be sufficient to restrain the purgative operation of the latter. When a speedier effect is desirable we give larger doses; such as five or ten grains every three, or even every two hours; or we combine mercurial inunction with the exhibition of calomel by the mouth. It is impossible to lay down any precise rule that will fit all cases. Blue pill, or else the hydrargyrum cum creta, may, in certain cases, be preferable to calomel; but they must be given in greater quantity.

"Mercury is of great service in many cases of chronic inflammation; and I may repeat here the observation I formerly made when speaking of blood-letting—that the treatment must keep pace, as it were, with the disease. When textures have been slowly altered by a gradual deposition of coagulable lymph, we should gain little or nothing by suddenly or speedily salivating our patient. The lymph, if it can be dispersed at all, must be gradually taken up again: and mercury, given with the view of promoting its absorption, must be slowly and gradually introduced into the system, and its specific influence, when at length it is felt, must be sustained for a considerable length of time."

Certain evil consequences are apt to follow the use of mercury. In fact, the symptoms of systemic infection by this mineral have a general resemblance to those of constitutional syphilis, or systemic infection by the syphilitic virus. But as, in most cases, the unfavourable action of mercury is fairly attributable to its immoderate or prolonged administration—an error of rare occurrence now-a-days—it is scarcely necessary to consider the treatment of mercurial poisoning.

Profuse salivation is, however, an exception which merits attention. Some persons are very easily salivated. In one case—related by Dr.

Farre—a lady was affected furiously, in a few hours, by two grains of calomel; prescribed as a purgative with some cathartic extract. She died at the end of two years, worn out, and having lost portions of the jaw by necrosis. Intense salivation is best relieved by the application of a few leeches to the swollen and painful glands. Smearing the gums with powdered tannin, will probably reduce their engorged condition, and give additional comfort. Gargling the mouth with weak brandy-and-water is another resource, not unfrequently successful in relieving the distress. Chlorate of potash, taken internally, is spoken of very favourably by Herpin, M. Ricord, M. A. Fournier, and Mr. Simon, as far as his trials of it have gone. The doses given were commonly ninety grains during the day; and it is expressly stated, that, while the inflammation of the mouth was thus effectually cured, the therapeutical influence of the mercury was in no degree diminished.

On the other hand, some persons are very difficult to salivate. Such cases are not uncommon, and unfortunately they seem most apt to occur when the controlling agency of mercury is most urgently required. In syphilitic cases of obstinate resistance to mercurialism, Mr. Simon finds that this insusceptibility often gives way, if tartarized antimony be administered in conjunction for a day or two; a half-grain dose, and then a few quarter-grain doses at eight-hour intervals.

Stimulants.—Wine, brandy, ammonia, or other stimulants, are necessary, whenever inflammatory fever has passed into a state of general depression and exhaustion, the natural sequence of nervous and vascular excitement. Requisite, therefore, as stimulants may be in proportion to the weakness manifested at even an early period, they are sure to become indispensable as the fever itself subsides. And on account of the local condition also, stimulants may be appropriate. When, in the course of inflammation, productiveness predominates, in the shape of effusion and suppuration, it will be necessary to support the circulation under the demand then made; and when destructiveness prevails, it will be even more imperative to sustain all the vital powers under the influence of poisonous matters absorbed in the course of suppuration, pyæmia, ulceration, or sloughing.

The "genuine effects of stimulation" are thus generally enumerated by Dr. Anstie, who has made this the subject of elaborate inquiry; but who, it must be confessed, has arrived at conclusions opposed for the most part to those of previous authors, and which are open to further clinical investigation. The effects observed are eight in number: "relief of pain; removal of muscular spasm, tremor, or convulsion; reduction of undue frequency of the circulation; reduction of excessive secretion; removal of general debility, or of special fatigue of the muscles, brain, or digestive organs; removal of delirium, or maniacal excitement, and production of healthy sleep; support of the organism in the absence of ordinary food; local increase of nutrition where this is deficient."

In regard to one of these effects, at least—"reduction of undue frequency of the circulation"—this view of the action of stimulants would be at variance with the known efficacy of administering them for the exhaustion consequent on inflammatory fever.

The kind and quantity of stimulant or stimulants which should be

administered, will vary greatly according to the age, constitutional strength, previous state of health and habits, of the individual. But the consideration of these particulars must be left to the experience and judgment of the practitioner in each case.

Tonics.—Cinchona bark, the mineral acids, sulphuric, nitric, nitro-muriatic, and other tonics, are useful under, perhaps, similar circumstances to those requiring the aid of stimulants, in the treatment of inflammation. Yet these two classes of remedial agents have different, perhaps opposite, effects, in some respects, although it is difficult to distinguish their operation in every particular.

A stimulant certainly produces its effects suddenly and transiently; a tonic, its effects more gradually and more permanently. Then again, the chief primary effect of the one is to quicken the circulation, as manifested by increased rapidity of pulse; while, the chief primary effect of the other is to strengthen the circulation, and hence an increased force of pulse.

Thus far these two kinds of agents contrast.

Both, however, concur in restoring the balance of the circulation from the depression connected with or consequent on the subsidence of inflammatory fever; and subsequently, in contending against the exhaustion of continued effusion or profuse suppuration; or again, in overcoming the depression arising from absorption of poisonous matters, in the course of suppuration, pyæmia, ulceration, or sloughing.

The mineral acids seem to exercise a special influence on the secretion of the skin, and, indeed, the secretions generally. Having administered the sesquicarbonate of ammonia, as a stimulant, with the tincture of bark or the disulphate of quinine, as a tonic, when first weakness supervenes; the ammonia should afterwards be exchanged for, say, the diluted nitro-muriatic acid; this tonic combination of bark and acid being the most effectual means of restraining the sweats of hectic fever, and of cleaning the furred tongue in gangrenous typhoid fever. The general improvement is often very remarkable, and permanent.

Cod-liver oil and *nutritious diet* are naturally associated; the one seeming to renovate the power of assimilation, the other supplying the materials for restoration. Both become appropriate, and nutritious diet absolutely necessary, on the subsidence of inflammatory fever, and during hectic, pyæmia, and gangrenous typhoid fever; whether for the reproduction of new blood and the general renovation of textural nutrition, or for the reparation of any local deterioration of texture, or loss of substance, consequent on inflammation.

Cod-liver oil may be regarded, partly, as a kind of food, supplying a limpid fat which passes easily into the circulation. In the first instance, it is not unfrequently rejected by the stomach or bowels. Beginning, therefore, with a moderate dose, not exceeding a teaspoonful, of pale, transparent, inodorous, and almost tasteless oil, taken twice or three times a day, this quantity may be gradually increased to a table-spoonful. It is best taken in a little milk, as an emulsion, or floating on orange wine, ginger wine, or other light cordial. The addition of a little diluted nitric acid is highly recommended by Dr. C. J. B. Williams; or if the tendency to nausea be extreme, the thirtieth or fortieth of a grain of strychnine in solution, with each dose of oil, will be found an excellent corrective. A further

precaution is, that the oil be taken ten or fifteen minutes after a meal.

The expression "nutritious diet," can scarcely be defined. It is assuredly the opposite to "antiphlogistic diet." Nutrition in the abstract, implies an adequate supply of all the proximate elements which form the textures and organs of the body; whereas the demand arising from inflammation must vary with the particular part affected. Nutritious food, of some kind, will be most needed in proportion to the supervention of suppuration, possibly profuse, and sloughing, possibly extensive. And experience, rather than any chemical knowledge, suggests an increased proportion of animal food, with a liberal allowance of ale or porter, as malt beverages, besides alcoholic stimulants.

(*b*.) *Removal of the Local Consequences of Inflammation.*—They are —productively,—effusion and its organization, suppuration, and the formation of abscess; destructively,—ulceration, sloughing, and mortification. As connected with inflammation, it would be unpathological to regard these local consequences otherwise than as continuations of this process; terminally, it is true, yet continuations of one and the same process, essentially.

The local remedial measures, therefore, which counteract the constituent elements of inflammation, are preventive of these after conditions.

But the removal of inflammatory products yet remains to be considered. This may be effected either by absorption, or by evacuation; the latter being aided generally by some operative interference.

Effusion, consisting of serum, fibrin, and exudation corpuscles, may be dispersed by a stimulating embrocation of ammonia and olive oil, or of camphor and soap liniment; by mercurial ointments, such as the unguentum hydrargyri nitratis; by the compound tincture of iodine, or by "iodine paint;" and by spirit lotions. The influence of some of these agents is aided by the friction employed in their application. Pressure, uniformly applied by even bandaging, will also promote absorption; and this may be aided by some stimulating agent used conjointly, as Scott's ointment to an enlarged knee-joint.

Absorption, is however, available only in chronic inflammation.

Incision will be appropriate when the inflammation is acute, and accompanied probably with considerable tension, as in phlegmonous erysipelas. In all such cases stimulating applications are inadmissible.

Suppuration becoming inevitable in any case, the secretion of pus should be encouraged, by quickening the inflammatory process. Abstaining, therefore, from the further use of any remedial measures for counteracting inflammation, the formation of pus is best insured by warmth and moisture topically applied, as by a light poultice, or moist spongio-piline.

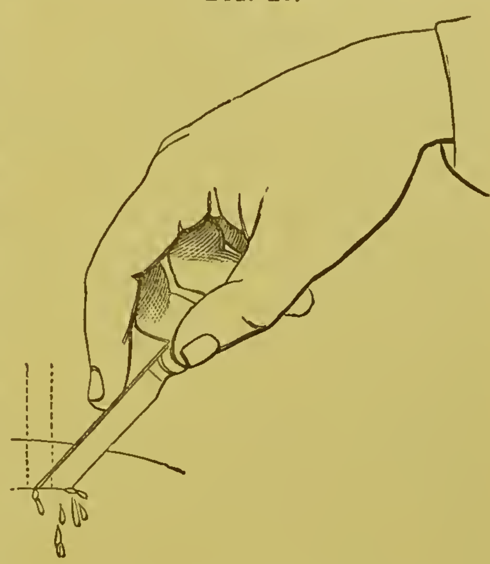
The absorption of pus is possible. Serum, the fluid portion of pus, is thus readily removed. Pus-cells must undergo a preparatory change. They disintegrate and re-enter the circulation; or remaining, in part at least, the broken-down pus-cells aggregate and form a cheese-like matter, which may at length become cretaceous. But the probability of absorption taking place, is little available for any practical purpose.

Abscess, or a collection of matter, generally tends to point, and the surgeon should then follow the footsteps of nature. An incision should

be made, whenever and wherever *pointing* has taken place, and of sufficient extent to allow a *free* opening for the evacuation of matter, and its discharge as secreted subsequently; these directions constituting the rule of treatment. Abscess in certain situations should be opened *early*; indeed, the surgeon cannot be too alert. Thus, in parts abounding with loose cellular texture, as the neck, axilla, groin, neighbourhood of the anus and vagina, popliteal region, and generally in the cellular planes between muscles. So also suppuration underneath unyielding fibrous expansions, and in the sheaths of tendons. Then again, when adjacent to mucous canals or important organs; as the trachea, pharynx, thorax, abdomen, urethra, rectum, and joints. Abscess, moreover, arising from irritant matters, as by the extravasation of urine or fæces, should be promptly set free. Abscess in situations less accessible, although urgent, perhaps, in other respects, requires some delay; as with regard to the lungs, liver, spleen, kidneys, and most internal organs.

A *dependent* opening, in order to facilitate the after escape of pus, has been particularly recommended, rather than an opening in the situation of pointing. But this practical injunction may be observed too absolutely; for wherever matter points, there, ultimately, an opening will take place. If necessary, however, a dependent *counter*-opening may also be made, to insure the ready discharge of pus as it forms.

Fig. 28.



To discover the presence of pus, the mode of opening an abscess is important. By introducing a bistoury perpendicularly, a drop of matter wells up along the side of the blade, or a half-turn of the instrument will enable it to do so. The puncture thus made is then readily converted into an incision of sufficient extent. (Fig. 28.) This little operation may be rendered painless by the topical influence of the ether-spray. But, by thus freezing the integument, which is already in a low state of vitality, sloughing is apt to follow; and this consideration may be of more consequence than immunity from a few moments' pain.

Thick and flaky pus, and especially when situated deeply, requires a proportionately more extensive incision. Extrusion of any texture, as muscle or fat, hindering the free evacuation of pus, may be obviated by inclining the blade of the bistoury, instead of withdrawing it, as the matter flows.

Hæmorrhage is usually slight and temporary. But in puncturing a deep-seated abscess, there may be some danger. Mr. Hilton, therefore, recommends that an incision be made through the integuments and fascia, so as to expose any muscle under which the pus lies; the cavity of the abscess should then be penetrated by a director, along the groove of which, as a guide, a slender pair of dressing forceps being

introduced, the blades are opened, the muscular fibres separated, and free exit is safely given to the pus.

Sometimes, the nature of a swelling or tumour may be doubtful; whether it be solid or fluid, and if the latter, whether an extravasation of blood, or an inflammatory effusion or pus. To clear up the diagnosis, before making an opening with a bistoury to discharge any such fluid matter, it may be advisable to introduce a grooved needle. A drop of fluid wells up along the groove, or any solid organized material lodged in the groove is abstracted by withdrawing the needle; and either product can then be examined by the naked eye or under the microscope. I often have recourse to this procedure.

The admission of air is generally of serious consequence, by inducing purulent decomposition and irritative fever or septicæmia, or prolonged suppurative discharge and hectic exhaustion. Hence, some precaution must be observed in opening any *large* and *chronic* abscess. A valvular aperture—as originally proposed by Abernethy—is the best safeguard. Having drawn the skin well to one side, a bistoury is introduced perpendicularly, as usual, but ere the matter has entirely ceased to flow, the integument is allowed to regain its former position; thus obliquely overlaying the aperture in the cyst. The external opening no longer directly communicating with the internal, any matter will continue to drain away without the ingress of air. Moreover, only so much pus escapes as may be discharged by the collapse of the walls of the abscess. It will, however, generally be better to close the opening, by sliding over it a small pad of lint, and then moderately compressing the whole cavity of the abscess, by means of a larger pad and bandage, to restrain the re-accumulation of matter. When the cavity has partly refilled, the same operation is repeated, and as often as may be necessary for the cyst to contract securely and finally close. But when a large chronic abscess occasions no inconvenience, it is a better rule not to open it, rather than endanger the patient's life.

Whether an abscess be acute or chronic, small or large, any thumbing or squeezing would be an unpardonable injury to the delicately organized and highly vascular lining membrane, which, previously pus-forming, should now become lymph-producing for reparation. On one occasion, having opened a large chronic abscess, situate over the gluteal region, I took the liberty of introducing my finger; deeming it advisable to do so, for the double purpose of turning out the uncommonly thick flaky matter, and of ascertaining whether the cyst communicated with dead bone; the case, a rare one, having simulated either disease of the hip-joint or of the sacro-iliac articulation.

The subsequent escape of matter will be insured by introducing a strip of lint through the incision, and into the cavity of the abscess, in order to prevent adhesion of the lips of the aperture, and to promote contraction and healing by granulation from the bottom of the cavity. This safeguard strip of lint is readily passed in with an ordinary probe or director, or with the flat handle of the scalpel. The strip is withdrawn in the course of a day or two, and a fresh piece not replaced, if a pus-discharging aperture be fairly established. If necessary, the discharge may be facilitated by the employment of a "drainage-tube," as recommended by M. Chassaignac. It is a small india-rubber tube with lateral holes; and this pipe may be passed, through a canula,

into the abscess, leaving one end hanging out, tho canula then being withdrawn; or the pipe, attached to a probe, is drawn through the abscess by a counter-opening, and both ends tied together. The objection to this proceeding, is the irritation caused by the tube, as a foreign body. In fact, it is a seton; and I have never yet seen any pus escapo through the tube. In *chronic* abscess—as of the lymphatic glands—with congested, bluish, and disorganized integument, whether thick and indurated, or thin and undermined, it may be advisable to open the abscess by the slower and more painful method of introducing a stick of *potass-fusa*, to provoke a healthy action in the part; or here the irritation of a seton, or a stimulating injection, may be resorted to with advantage. But dressing the cavity from the bottom with lint, will generally prove sufficient.

Otherwise, the dressing of an opened abscess should be unirritating. A light poultice may be applied to encourage the discharge of pus, during the process of granulation from within; or the application of a piece of lint to close the aperture, as soon as possible, will be appropriate, when the abscess is to be reopened from time to time.

Abscesses by "translation," and "secondary abscesses" in the course of pyæmia, should be treated as chronic abscesses; and the more so the larger the size to which they have attained. A valvular opening therefore should be made, and closed with a piece of lint after the tension of the sac is sufficiently relieved, this being repeated when necessary. Obviously such treatment relates only to external, or at least to accessible parts.

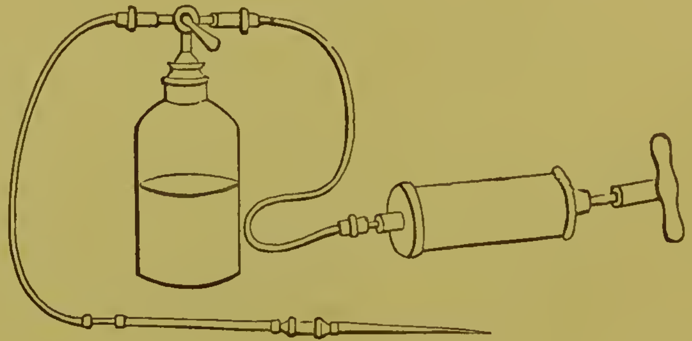
The *antiseptic method* of opening an abscess was devised by Professor Lister, with the view of counteracting any contaminating influence from the surrounding atmosphere—due perhaps to germinal matter—and of thus precluding the decomposition of pus, consequent on the admission of air to the cavity of the abscess. Accordingly, the abscess is opened with a bistoury in the usual manner, but under the protective influence of some agent, which seems to possess the power of opposing any such septic change in animal matter—an *antiseptic;* and for this purpose, carbolic or phenic acid is generally employed. The *method* of treatment consists, either in surrounding the abscess with an antiseptic atmosphere of carbolic acid; or of placing the abscess under a fluid, such as oil, which has been rendered antiseptic. Then the opening is made, apparently with greater safety than when thus unprotected. The former method is practised by throwing a spray of carbolic acid solution upon the part, thus creating an antiseptic atmosphere; and the blade of the knife may also be dipped in the solution, which should be of moderate strength, about one part of the acid to eighty of water. Under cover of an antiseptic oil, say one part to four of linseed oil, an abscess may be opened yet more securely, or the matter may be allowed to escape from under a layer of lint soaked in the oil. After either of these methods of opening an abscess with antiseptic precautions, the opening should be dressed with carbolic acid paste, or the oil, thickened with chalk, and then covered with tinfoil, the more effectually to preclude the admission of air.

I do not find, in practice, any unequivocal advantage from the antiseptic method of treatment; and I am disposed still to rely, as I have done for years with quite equal success, upon the security afforded

by those general hygienic arrangements, in regard to clean air and clean dressings, which prevent the necessity of having recourse to any antiseptic measures. In short, I advocate what may be termed *pre*-septicism, instead of *anti*septicism, in the practice of Surgery. Why admit an enemy, in the shape of an impregnated atmosphere, to the bedside, and to the wound, of a patient; and then devise means to oppose the entrance of that enemy, through this breach, into the fortress of life? Those Surgeons are to be pitied who seem compelled to practise the Art of Healing, amid the perpetually adverse and embarrassing circumstances of foul air, and perhaps foul appliances, in an Hospital which had far better be destroyed to below its foundation and rebuilt, or removed to another site—as in the case of the Norwich Hospital—and which should be constructed, and appointed, with the hygienic provisions for health to each patient. Otherwise, the Surgeon must ever be in battle with an unseen, subtle, and deadly foe; until, at last, from dire necessity, he invents some "*anti*septic system of treatment," which is founded in conjecture, and, with ever-changing tactics, is followed in despair. Nevertheless, Professor Lister deserves great credit for the courage and skill he has so long displayed in fighting this unequal battle with the shadow of death; by what further means of warfare, and the apparent conquests he has gained, will be seen in the treatment of Open Wounds. Fortunately, however, even under the unfavourable circumstances of the most insalubrious Hospital, an abscess can be opened without the slightest risk of any contaminating aerial influence, by a method which entirely precludes the admission of air, in the following manner:—

Subcutaneous pneumatic aspiration supplies the requisite method of drawing off a purulent collection, without the possibility of air entering the cavity of the abscess. A fine needle-like canula is thrust into the abscess, with a slight rotatory movement to facilitate the passage of this slender instrument, which is attached by a caoutchouc tube to a receiving bottle—the aspirator (Fig. 29)—from which the air has been

Fig. 29.



exhausted by means of a small pump. Needles of various sizes are used. according to the thickness of the fluid; and a small wire-stylet is provided to keep the passage clear. The purulent fluid is seen to pass into the bottle, descending in a steady stream, until it ends in dropping and may be slightly tinged with blood; when the needle should be withdrawn from the abscess. Now and then, a more complete vacuum may be maintained by working the pump.

Aspiration is due to the ingenuity of Dr. Georges Dieulafoy; and in his hands, coupled with the practice of most surgeons, this method of treatment has been extended to the removal of any collection of *fluid;* while it is applicable alike for the purpose of exploratory puncture, in diagnosis, without the admission of air. The tube near the needle is interrupted by a piece of glass-tube; so that the puncture cannot penetrate beyond even a layer of fluid, without some portion traversing the glass window,—being sucked up, as it were, by the aspirator. The diagnosis is at once indicated. This method is specially serviceable to determine the presence and nature of a fluid, when the collection is in small quantity, or deeply seated. Thus, aspiration has been employed successfully, whether for diagnosis or treatment, in abscess within joints, or under the muscles of the thigh, in the gluteal region, or in the iliac-fossa; or as affecting internal organs, such as the liver or kidney. Cystic ovaries, or cysts within the pelvis, have been submitted to aspiration, through the abdominal wall, or per vaginam. Effusions within the skull, in hydrocephalus; into the pericardium, the pleural or peritoneal cavities, have thus been safely withdrawn; and the hernial sac may be relieved of fluid, so as to admit of effectual taxis, in returning the visceral protrusion. Collections of blood, which may have become partly coagulated, yield less readily to aspiration. Yet I have drawn off a mixture of bloody serum, to the amount of fifteen ounces, consequent on extensive bruising of the back. But, in all cases, the fluid is apt to re-accumulate, especially when pressure cannot be brought to bear upon the part. Lastly, in retention of urine, supra-pubic puncture with the aspirator, affords the means of speedy and safe relief; and which may be resorted to several times with impunity.

Complications of Abscess.—Hæmorrhage into an abscess sometimes occurs, and either before or after it has been opened. The source of the bleeding may be *capillary*, from the highly vascular pyogenic membrane; and then the hæmorrhage is of an oozing character. It usually occurs when the abscess is opened, and the nature of the case is plainly declared by the admixture of blood with the pus, or the discoloration of the purulent discharge afterwards. This form of hæmorrhage arises partly from the capillary vessels yielding under the loss of pressure of the fluid which had occupied the cavity of the abscess; but the bleeding proceeds principally from the unsurgical thumbing and squeezing to which an abscess is sometimes subjected, in order to empty the cavity; and sometimes there may be a constitutional tendency to hæmorrhage, as from scrofula or purpura, or in the hæmorrhagic diathesis. Arterial or venous hæmorrhage arises from *ulceration* laying open an artery or vein of some size; and then the bleeding is sudden and profuse. This may occur before or after the opening of the abscess. In the former case, the nature of this complication is indicated by the sudden enlargement of the swelling; and when the hæmorrhage is arterial, by the pulsating character of the tumour. But these signs are often obscure, and in the latter case, the abscess can only be distinguished from an aneurism by any marks of inflammatory action and the previous history.

The *treatment* of these different forms of abscess-hæmorrhage will vary accordingly. Capillary bleeding may be restrained, by laying the abscess freely open, and then applying a compress and ice-bag.

Venous hæmorrhage may perhaps be stopped by the further support of plugging, with a styptic solution of iron, placed well home upon the bleeding vessel. But where the hæmorrhage is arterial, it cannot be arrested by compression, or by ligature of the vessel alone within the cavity of the abscess, for there the ulcerated or sloughy state of the part forbids the attempt, which might be followed by a fatal recurrence of the bleeding at any time; but we may perhaps trust the additional compression of the main artery above the abscess, or recourse must be had to ligature of that vessel.

Another complication of abscess may be mentioned, as occurring sometimes when the collection of matter is situated adjoining a mucous canal. Air permeates the cavity of an abscess so placed, or gains access by ulceration; or gas may perhaps be generated by decomposition of the matter contained within the cavity; constituting what has been named a *tympanitic* or *emphysematous* abscess. This change takes place more frequently in abscess lying against the rectum or the pharynx. The sound elicited by percussion, or a gurgling sensation on manipulation, will suffice to make known the admixture of air and purulent fluid, when the situation of the abscess admits of this mode of examination.

No special mode of *treatment* is required; but an early and free vent should be given to the contents of such an abscess, and the cavity syringed out with an antiseptic solution.

Sinus and *fistula* require special treatment, in some respects. Any assignable local cause having, if possible, been removed, as a piece of dead bone, or other foreign body; pressure by a graduated compress and bandage, will succeed occasionally in bringing about adhesion, if the sinus or fistula be recent and accessible. Drainage affords an efficacious resource when the fistula remains open, owing to the collection of purulent matter below the level of the external opening, or too deep in to have a free discharge. The matter may then be allowed to drain away, either by inserting a piece of drainage tube, or by making a counter-opening; but a proper position of the part will sometimes secure the requisite freedom of discharge. The tube acts also as a seton, and so far may promote the healing of the fistulous track; but it must be withdrawn in a few days, lest it should provoke continued suppuration. When induration has taken place, or pressure cannot be applied, stimulating injections of sulphate of zinc or nitrate of silver, sometimes answer the purpose. Or a red-hot wire introduced up the passage, may prove successful. This is conveniently accomplished by Mr. Marshall's apparatus, whereby a platinum wire, introduced cold, is made red-hot instantaneously by the galvanic current. Generally speaking, however, a sinus or fistula having become indurated, it obstinately resists any attempt to excite adhesion. Slitting up the passage with a curved bistoury, on a director if necessary, and healing by granulation from the bottom, must then be had recourse to. A familiar illustration is the operation of fistula in ano. Whenever the persistence of a fistula depends on some constitutional cause, the general health must be attended to accordingly; as in the case of scrofulous disease of bone, with fistulæ leading down to caries or necrosis.

The *destructive* consequences of inflammation, *i.e.*, ulceration and sloughing or gangrene, severally present certain indications of treatment.

Ulceration—as depending on inflammation—may be arrested by counteracting any of the constituent elements of inflammation, which are still in operation. Local antiphlogistic treatment, including rest and an elevated position of the part, is indicated. During reparation, the process of suppurative granulation needs little or no assistance. Warmth and moisture, by means of a light poultice or spongio-piline epithem, may be continued while the chasm is filling up; rest and position being still observed. Superfluous organizable material—pus—is discharged; and when the granulations have grown to the level of the skin, and are no longer suppurative, the aid of a poultice may be discontinued. Water-dressing, simply to exclude the irritating action of the air, is then alone necessary. This application should be exchanged for some slightly stimulating wash, if the pale and flabby state of the granulations suggests the propriety of so doing. A weak solution of sulphate of zinc answers very well. The pressure of a bandage will aid its effect, and repress any exuberant growth.

Sloughing and *gangrene* are, in like manner, amenable to local antiphlogistic treatment, with the view of arresting the process of destruction.

Effusion—always an essential constituent of inflammation—is here the element, in particular, to be counteracted or its effect overcome. The relief of tension is imperative. Hence, incisions as free as may be necessary, are the primary indication of treatment. Its efficacy is witnessed in phlegmonous erysipelas and carbuncle.

The process of separation of the living from the dead textures, must be encouraged. Warmth and moisture, by a poultice or spongio-piline epithem, or the more stimulating action of a yeast poultice, will be highly serviceable, both in limiting the sloughing and inducing the detachment of slough. The latter kind of poultice has the advantage of destroying the fœtor of decomposing textures. Charcoal in powder, chlorides of lime or zinc, and carbolic acid, are also valuable antiseptic applications. It should, however, be remembered that any stimulant application may overact, and by hurrying on the inflammation beyond that requisite for the ulcerative severation of textures, would cause the gangrene to spread. The line of separation having formed, the detachment of slough has yet to take place. During this period, its extraction prematurely would be attended with hæmorrhage, perhaps considerable. Nature may be aided gently, from time to time, by slight manipulative interference, here and there.

Finally, the removal of slough is an obvious indication which can hardly be overlooked. Dead soft textures are easily withdrawn by the finger or forceps; a sequestrum will require to be extracted from the encompassing sheath of new bone.

The healing of soft textures, subsequently, is by granulation; and the treatment that for a simple healing ulcer.

Thus ends the local treatment of inflammation, in its consequences, productively and destructively.

The treatment of the concomitant *constitutional* disorders—hectic fever, arising from suppuration, and the typhoid fever arising from gangrene—is represented by those constitutional remedial measures which come into use as the inflammatory fever, declining, is succeeded by general weakness and excitement. Stimulants and tonics on the one hand, with opium, and a nutritious diet, constitute the resources referred to.

Pyæmia, also, is amenable to this plan of treatment, if, indeed, it be subject to any remedial measures.

Varieties of Inflammation.

The excess or the defect, or, it may be, the peculiar character, of one or more of the constituent elements of inflammation, gives rise to corresponding varieties. The principal are as follows:—sthenic and asthenic; acute, subacute, and chronic; phlegmonous; congestive; erysipelatous; diphtheritic or pellicular; hæmorrhagic; and certain specific inflammations; as the scrofulous, the gouty, and rheumatic, the syphilitic and the gonorrhœal.

The *sthenic* and *asthenic* varieties of inflammation, observes Dr. C. J. B. Williams, are referable to a difference in the strength and irritability of the heart and arteries, and in the quality and quantity of the blood which they propel. Sthenic inflammation is marked by a strong, hard pulse, high fever, very fibrinous blood, a full and active development of the chief symptoms of inflammation, and a tendency to the effusion of the more plastic products. This form of disorder occurs in subjects of the most robust constitution, in whom therefore the effects of disease are most readily shaken off. Asthenic inflammation occurs in persons, the tone and real strength of whose vascular system is low, and whose blood, generally speaking, is poor. The pulse is not always affected; but when it is so, it is in frequency rather than in strength or firmness; the fever, if there be any, is of a slight, remittent, or low character. The products are either scanty, or of a cacoplastic or aplastic nature; or the effusion may be chiefly serous, the inflammation differing little from flux and dropsy.

Treatment.—*Sthenic* inflammation requires the early and more free use of reducing measures—blood-letting, local and perhaps general, purgatives, antimony, and mercury. The system tolerates this antiphlogistic treatment better than in other varieties of inflammation, and if employed in time, it is commonly successful, as the vigour of the constitution naturally tends to recovery. *Asthenic* inflammation, on the contrary, admits of less reducing treatment; and early recourse to stimulants and tonics, with a generous diet. Thus, bark or quinine, ammonia, wine, brandy, and animal food, must be soon administered.

Acute, *subacute*, and *chronic* inflammation properly relate to its duration, but these terms are often used as synonymous with sthenic and asthenic. Acute inflammation may be, and commonly is, sthenic, but its distinctive character is, that it tends to a speedy termination of some kind or other. It may end in resolution, effusion, suppuration, or gangrene, in a period varying from a few days to three weeks. An inflammation lasting above the latter period is termed subacute, and if protracted beyond six weeks is properly called chronic. The latter is commonly asthenic, though it sometimes presents a good deal of the sthenic character. Acute inflammation, when at all extensive, is attended with considerable fever and constitutional disorder. With subacute inflammation the fever is less, and may even be absent. In chronic inflammation there is rarely much fever, and when present, it is of a remittent or hectic kind.

The products of acute inflammation are commonly copious and dis-

tinctive, being either free coagulable lymph or pus. Chronic inflammation results chiefly in pus-formation, or in contractile lymph-deposit; while in subacute inflammation, the products are often of intermediate nature, as purulent lymph or curdy matter.

Treatment.—Acute inflammation demands also the prompt use of antiphlogistic measures, regulated, however, by the more or less sthenic character of the symptoms. The *subacute* variety, marked by less febrile symptoms, but of longer duration, in a continuous or recurring form, suggests a moderation of such treatment, and its renewal from time to time as occasion may indicate. Mercurials with opium are often the most efficient remedies. *Chronic* inflammation rarely admits of any reducing measures, but needs a stimulant and tonic plan of treatment, with mild mercurials, sustained by a nourishing diet; this course being prolonged for probably a considerable period. The local treatment, equally tedious, must be directed to the removal of the inflammatory products, by blistering, iodine, stimulating embrocations, pressure, and other applications to promote absorption. Chronic abscess should be treated as explained in noticing the local consequences of inflammation, generally.

Phlegmonous inflammation is illustrated in the phlegmon or common boil of the skin. Its chief feature consists in its being abruptly circumscribed by an effusion of solid lymph, which brings the inflammation to a termination, either by suppuration, or by slow subsidence, as in blind boils. A highly fibrinous condition of the blood contributes to render inflammation phlegmonous, but this form of inflammation is commonly exhibited by cellular and parenchymatous textures. The type of phlegmonous inflammation is usually sthenic; and even when it advances to suppuration or sloughing, it defends the system against the noxious influence of the pus and dead matter. Hence, the fever is inflammatory, and the local pain, irritation, and heat are considerable.

Treatment usually should be similar to that which is appropriate for inflammation of the sthenic type; though the febrile disturbance may be asthenic, as is often the case in boils and phlegmonous erysipelas. But the tension of the part affected always demands relief by early and free incisions.

Congestive inflammation is that in which the accumulation of the blood in the vessels of the affected part, and retardation of its movement, predominate over the determination of blood. Hence it is commonly asthenic, and generally originates from causes that produce congestion, the reaction which converts this into inflammation being imperfect or partial. Its symptoms are less prominent than those of more active inflammation, and partake more of the character of congestion. There may be little pain, heat, or fever; but the redness, where visible, is more marked and deeper than usual, and if the affected organ be very vascular, as the liver, lungs, and kidneys, the swelling may be considerable. Congestive inflammation is usually subacute or chronic, not tending to speedy results; but a kind of flux or dropsy may occur early, as happens from congestion. The solid effusion ensuing is generally cacoplastic; thence the consolidations or indurations resulting, are often of a dense indolent kind, tending to contract or to degenerate still further into aplastic matter. Inflammation of the lung supervening on disease of the heart, on bronchitis, and

on asphyxia, is generally congestive; and so is inflammation of the liver, as arising from any cause.

Treatment, both constitutionally and locally, will be that which is suitable for the subacute and chronic varieties of inflammation. But the congestive character of this variety seems to be specially amenable to mercury and antimony, as witnessed in the treatment of hepatitis and pneumonia respectively. At a later period, with a lax state of the vessels in the part affected, the mineral acids are very favourable, as part of the tonic treatment.

Erythematic or *erysipelatous* inflammation contrasts with phlegmonous in its tendency to spread, owing to its not being attended with the effusion of plastic lymph. In its severe form, it is accompanied by much redness, pain or smarting, heat and swelling; the effusion is chiefly serous or sero-purulent, and often raises the cuticle in blisters. It may issue in resolution; but in its worst form, it terminates in diffused suppuration, sloughing, or gangrene. The fever is asthenic, or even typhoid, and of an infectious character.

Treatment.—Depletion will be sufficiently accomplished by salines, aperients, diaphoretics, and diuretics, without having recourse to any blood-letting or other active antiphlogistic measures. But this treatment must soon give place to stimulants and tonics—ammonia, bark, and particularly iron,—the sesquichloride of iron seeming to be specially beneficial, with a generous diet of wine, brandy, eggs, beef-tea, and other easily assimilated animal food. To prevent the spread of infection; isolation of the patient, free ventilation, cleanliness with regard to dressings, and the use of disinfecting agents, as by chlorine vapour and chlorinated washes, constitute our chief resources. The general plan of treatment, thus indicated, is more fully described in detail under the head of Erysipelas.

Diphtheritic or *pellicular* inflammation of mucous membranes is somewhat allied to the erysipelatous, being diffused and spreading, generally asthenic, and accompanied with a low kind of fever. But it is attended with more soreness than pain, little swelling, and a deep redness, which is early obscured by a characteristic film of grayish or dirty-white albuminous matter, exuded on the inflamed surface. Patches of this kind often occur on the tonsils in sore throat, resembling sloughs. In scarlatina sometimes, diphtheritic inflammation affects the whole throat, and extends even to the trachea and bronchi, and into the mouth and gullet. The films of lymph effused are often fœtid, apparently from incipient decomposition.

Treatment should be in no sense depletory or reducing, but similar to that for the erysipelatous variety; excepting perhaps in the employment of mercury, with the view of controlling the pellicular exudation. Stimulant and astringent applications to the fauces may prove efficacious: the nitrate of silver, pencilled, or applied in a strong solution, by means of a glass brush; dilute mineral acids, the nitric or hydrochloric, one part to two or three of glycerine; or solutions of alum or sulphate of zinc. A borax gargle, consisting of three or four drachms of borax, with an ounce of honey, to a pint of water, will also be serviceable for cleansing the throat and correcting the fœtor of the exudation.

Hæmorrhagic inflammation is attended with effusion or extravasation of blood, in a greater or less degree. It occurs in subjects

scorbutic or affected with purpura, and in connection with disease of the liver or kidneys. Thus, Dr. C. J. B. Williams has met with several instances of hæmorrhagic pleurisy and pericarditis in conjunction with cirrhosis of the liver, and Bright's disease of the kidney.

The *treatment* forms part of that which is appropriate for whatever disease with which this variety of inflammation may be associated.

The *specific* inflammations in Scrofula, Rheumatism, Gout, and Syphilis, will be fully described under these different titles, among Blood-diseases.

CHAPTER II.

TUMOURS OR MORBID GROWTHS.

Morbid Growths present certain general characteristics, in respect to their structure and vital endowments, which may be advantageously noticed, before describing the various species of Growths.

1. In common with all other Morbid Products, Morbid Growths are products supplemental, in the sense of being additional, to the parts of the body in which they occur. They form Tumours.

2. In their textural structure, and in their physical properties, Growths generally resemble the various healthy tissues in which they severally originate. There is a structural homology or at least analogy between the two, and their structural elements are similar if not identical; but there may be an apparent structural difference, or heterology. Growths are, therefore, sometimes designated Homologous or Heterologous; according as they represent a lesser or greater degree of structural departure from the normal condition of the tissues in which they are formed. Virchow proposed the terms Hyperplasia and Heteroplasia to represent these relations of Growths, and of New formations generally, to the normal tissues of the body.

Growths, in common with other organized Morbid Products, do not generally attain to the same state of textural development as healthy tissues; they so far represent structural retrogressions of the normal tissues to various rudimentary conditions, by arrests of development of their structural elements.

In their degree or grade of organization, Growths represent states of textural structure, at least as highly developed as the False tissues produced in the Reparation of Injuries or resulting from Inflammation.

3. A Growth generally presents a well-defined boundary, often a distinct capsule, by which the included structure can be readily distinguished circumferentially from adjoining textures.

By virtue of their structural homology or resemblance to healthy tissues, Growths may perhaps be regarded as hypertrophies or overgrowths, but as discontinuous from the surrounding tissues; while, by the latter character, they are distinguished from out-growths or hypertrophies continuous with the adjoining tissues, *e.g.*, out-growing portions of the thyroid and prostate glands.

4. The vital power of Growths is peculiar, and exhibits their

essentially morbid character. They possess the inherent power of reproducing their own structural elements, when adequately supplied with blood or plasma as the nutritive material suitable for their production. Hence, I would designate Morbid Growths products of Reproductive Nutrition. They thus increase and multiply. But another vital characteristic is this; they apparently fulfil no useful purpose in the animal economy.

It is not, observes Sir James Paget, in the likeness or in the unlikeness to the natural tissues that we can express the true nature of Tumours; it is not enough to consider their anatomy, their physiology also must be studied; as dead masses, or as Growths achieved, they may be called like, or unlike, the rest of a part; but as things growing, they are all unlike it. It is, therefore, not enough to think of them as hypertrophies or over-growths; they must be considered as parts overgrowing, and as overgrowing with appearance of inherent power, irrespective of the growing or maintenance of the rest of the body, discordant from its normal type, and with no seeming purpose.

Such are the general structural characters, and such the general vital endowments of Growths, or Tumours.

But the vital changes of certain Growths contrast remarkably with the progress of others.

Some appear to exercise a merely local and mechanical influence; their pathological significance is limited to surrounding parts, which are variously pressed, obstructed, and, possibly, obliterated by absorption. Inflammation, suppuration, and ulceration occasionally occur in parts around, owing to pressure of the tumour, and thus a pendulous growth, more especially, may protrude. Otherwise, the healthy mechanism only of the part becomes impaired by these *localized* Growths.

Moreover, when completely extirpated, as by the surgical operation of excision, they never return. Other Growths are localized, but they are also *recurring;* returning *in situ*, even again and again, when apparently completely extirpated. And yet other Growths are recurring but not localized; they gradually pervade surrounding tissues, and affect neighbouring lymphatic vessels and glands; they are prone to undergo ulceration, and by extension of this process thus destroy adjacent parts. They propagate also in different and distant regions of the body, and grow in succession and with increasing rapidity. Growths having these vital characters, are aptly denominated *infiltrating* (Walshe) or *malignant*,—a less expressive term; while all other Growths being distinguished by the negation of this generic attribute, are non-infiltrating or innocent, comparatively speaking.

According to the clinical distinctions already noticed, coupled with some Anatomical or Histological differences of Species, Morbid Growths may be classified as follows:—

Localized Growths (non-infiltrating).
  Cysts.
    Simple or barren.
      Serous. Sanguineous. Synovial.
      Mucous. Oily. Colloid. Seminal.

Compound or Proliferous.
Cystigerous. Glandular. Cutaneous. Dentigerous.
Cystic Tumours—*e.g.*, Fibrous. Cartilaginous.
Fatty Tumour. Lipoma.
Steatoma.
Sarcoma (Virchow):—
Fibro-cellular Tumour.
Painful Sub-cutaneous Tubercle. Neuroma.
Glioma. Myxoma. Psammoma. (Virchow.)
Fibrous Tumour.
Fibro-calcareous. Fibro-cystic.
Recurring Varieties. { Fibro-nucleated. Recurring Fibroid.
Cartilaginous Tumour. (Enchondroma.)
Fibro-Cartilaginous. Ossific. Mixed with other Growths.
Recurring Varieties. { Myeloid. Fibro-plastic. (Paget, or Lebert.)
Granulation Tumours. (Virchow.) Elephantiasis.
Syphilitic Tumours—*e.g.*, Gummy Tumours; Lupus; and Swellings of Glanders and Farcy.
Vascular or Erectile Tumours. (Angioma.)
Nævus.—Telangciectasis.
Aneurism by Anastomosis.
Osseous Tumours.
Glandular Tumours. Lymphoma. Adenoma.
Papillary Growths. Warts. Horns.
Infiltrating Growths.
Cancer.
Encephaloid. Varieties.—Villous. Melanotic. Fungus Hæmatodes.
Scirrhous. Varieties.—Osteoid.
Colloid. Varieties.
Cystic Cancers.
Epithelial Cancer. Varieties.

General Etiology.—(1.) *Pathogeny of Morbid Growths.*—As distinguished from the Pathology or Structure and Vital History of Morbid Growths, their Pathogeny or Generation is an inquiry of great interest and practical importance.

The *origin* of Morbid Growths appears to be similar to that of Inflammatory Products, in their being either textural geneses, or referable to morbid conditions of the blood—dyscrasiæ. Virchow, Rindfleisch, and O. Weber concur in regarding Tumours as of local origin; Billroth and other pathologists equally incline to their constitutional production.

According to Virchow's theory, new formations, whether as inflammatory products, or as new growths or tumours, are produced from the germs with which connective tissue and derivative tissues are said to abound; this common stock of germs being the source of new formations, instead of the plastic lymph, blastema, or exudation matter, which has so long been accredited. This theory of "continuous textural development," in opposition to the "blastema" theory, is based upon two species of evidence: the absence of any discernible

exudation of amorphous matter, prior to the appearance of organized elements; and the discovery that connective tissue, and its equivalent tissues, as bone, are full of germs or cell-elements. Thus the body is said to consist of a more or less continuous mass of connective-tissue-like constituents, in which, at certain parts, other things, such as muscles and nerves, are imbedded. It is in this more or less "connected framework" that germinal new formation goes on, and in accordance with the same law which regulates embryonic development. The histological origin of new formations would appear to occur in either of two ways: generally, by cell-division; by endogenous development, in some instances.

The *relation* of Morbid Growths to Healthy Tissues has engaged much attention. So long since as 1857—twenty years from the time I am now writing—I endeavoured to establish a general Law of "Structural Retrogression," * which explains the relation of Morbid to Healthy Histology, and the generation of Morbid Growths—extending to Organized Morbid Products, in general—from Healthy Tissues. Subsequently, I ventured to formulate this Law in the following terms: "that Organized Morbid Products are merely *persistent rudimentary* conditions of the structural elements of their analogous *Healthy* Tissues, by *arrested* development of those elements;" † "that such Products, including 'New Growths,' representing only so many developmental conditions of analogous Healthy Tissues, are severally formed by so many *arrests* of *their* development;" and that "Degenerative retrogressions of the original tissues are formed by so many *relapses* to as many more simple, although not developmental, conditions of their structural elements." ‡

(2.) *External* causes, *e.g.*, mechanical injury, chemical agents, and the influence of cold, have a very uncertain relation to the production of Morbid Growths. Such causes commonly give rise to inflammation, acute or chronic; they rarely result in the formation of any Tumour, properly so called. Pathologists, however, are divided on this question.

General Indications of Treatment.—From the general pathology of Morbid Growths, and their relations to the developmental anatomy of Healthy Tissues, certain general indications of treatment are deducible.

1. To reduce the structural condition to a lower degree of retrogression, by degeneration or by disintegration, in order to facilitate absorption of the Tumour. Medicinal agents, and local appliances, *e.g.*, stimulating applications, compression, may fulfil this indication.

2. To superinduce some other morbid process, *in situ*, for the direct suppression of the Growth, and its obliteration or destruction as a Tumour. Inflammation, or Sloughing, by stimulant injections, setons, caustics, congelation, may fulfil this indication.

3. To remove the Tumour, as such, mechanically, by surgical operation; puncture, enucleation, ligature, excision, amputation.

Special Tumours.—Morbid Growths are severally distinguished by differences or peculiarities, in respect to their structural condition, and physical characters of shape, size, weight, consistence, colour, situation, and number produced; and by their vital history of origin, including

* "What has Pathological Anatomy done for Medicine and Surgery?" Ten serial Essays. *Lancet*, 1857.

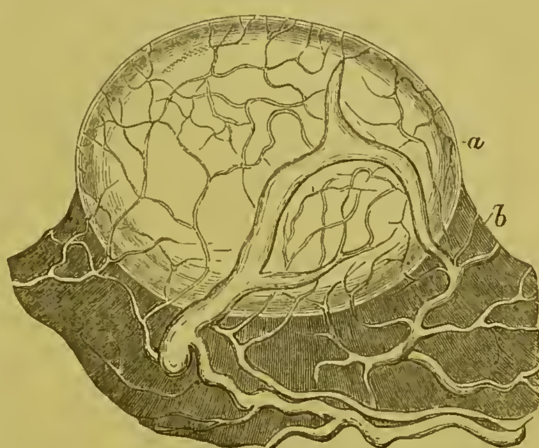
† "Principles of Surgery" (1864), p. 25. ‡ Ibid. p. 93.

hereditary predisposition and relations to age and sex; causes—constitutional and local; course, and consequences. In other words, Growths have differences of character—pathologico-anatomical, physiological and pathological, in regard to species. These differences I proceed to describe and to consider in the diagnosis, etiology, and prognosis of the various kinds of Tumours, as arranged in the foregoing table. The special Treatment of each will also be described, in illustration of the general indications already enunciated.

Cysts and Cystic Tumours.—*Structural Condition.*—This is very varied. (1.) Cysts.

"Essentially, this species of growth," observes Paget, "is a cyst, sac, or bag, filled with some substance which may be regarded as entirely, or for the most part, its product, whether as a secretion, or as an endogenous growth." This cyst (Fig. 30), sac, or bag, is either solitary, or frequently aggregated with others; and each may be free and movable, or imbedded in the substance of some other growth, thus forming a "cystic tumour." But the contents of the cyst or cysts are the chief features of distinction.

Fig. 30.*



Some contain fluid unorganized secretions, and are spoken of as *simple*, or more correctly, *barren* cysts.

Others contain organized, endogenous growths, and these are denominated *compound*, or more appropriately, *proliferous* cysts. (Fig. 31.) But the simple sac is the type, from which the proliferous cyst may be regarded as a departure to a more complex condition; and between the former in its simplest state of development, and the latter in its most anomalous condition, each intermediate variety may be distinguished by the contents of the cysts, and the whole arranged in a tolerably even series of progressive organization.

Fig. 31.†

* A simple cyst in the broad ligament of the uterus, with very vascular walls. —*a.* New vessels. *b.* Broad ligament. 30 diam. (Wedl.)

† Proliferous cyst in a mammary gland.—A vascular growth is seen attached to part of the inner surface of the cyst. Below is a smaller cyst nearly filled with a similar growth. Mus. St. Bartholomew's Hospital. Three-fourths the natural size. (Paget.)

Simple Cysts.—A cyst is formed of fibro-cellular tissue, but without an epithelial lining. This is present in the more finished cysts, and is usually the tessellated variety of epithelium. A more perfect secreting surface is thus prepared, and the varieties of simple cysts take their names from the nature of their secretions—their contents. Thus we recognize the *serous*, *sanguineous*, *synovial*, *mucous*, *oily*, *colloid*, and *seminal* cysts.

These barren cysts may be found in almost any part of the body—and to this subject I shall have occasion again to refer in connection with the origin of cysts—but the seminal cyst has, so far as I am aware, been found attached exclusively to the spermatic cord, and by virtue of the spermatozoa which it contains, may be regarded as on the verge of that higher organization which characterizes the proliferous cyst.

Proliferous Cysts.—The organized growths within a proliferous cyst are sometimes simple cells, detached, or pedunculated and attached to the interior of the cyst whence they have sprung. Thus are formed the common *cystigerous* ovarian tumours. Occasionally the sub-cysts are found imbedded in the walls of the parent cyst, or even projecting from its external surface, so as almost to appear of exogenous formation. This mode of cyst-formation is, I think, illustrated by inference from Dr. Mettenheimer's observations on the structure of the common hydatid mole, or cystic disease of the chorion; but for the details of this supposed process the student is referred to Sir James Paget's Lectures.

Glandular proliferous cysts are so named from their containing some kind of organized substance or substances, the structure of which resembles some kind of healthy gland-tissue, and for the most part that in which the cysts are imbedded. The thyroid and mammary glands, and perhaps the prostate and labial glands, are the chosen seats of this species of cyst. But a glanduliferous cyst may be developed apart from any connection with a secreting gland. A tumour of this kind was removed by Paget from beneath the gracilis and adductor longus muscles of a woman twenty-five years old. The patient remained well at the end of more than three years afterwards. A similar case and operation occurred to Lawrence.

Cutaneous proliferous cysts are so called from their structure consisting of, or containing skin or its remains, with hair, or other forms of epidermic tissue, and fat. These cysts are not necessarily confined to the skin, as sebaceous and atheromatous tumours or wens, but are more commonly found in ovarian tumours; and, very rarely, in the testicle, lung, kidney, bladder, sublingual tissue, and within the skull. Teeth may also be discovered within capsules in abnormal situations, as in ovarian tumours, and the jaws; and such capsules have received the name of *dentigerous* proliferous cysts.

Signs and Diagnosis.—The signs and the distinctive characters of cysts are chiefly physical; their diagnosis from all other tumours being an application of pathological anatomy, through the medium of Physical Sign

A *simple* or barren cyst, with its fluid contents, necessarily implies a circumscribed and fluctuating tumour, or the resistance only of fluid pressure. Such are cysts,—serous, sanguineous, enlarged synovial bursæ, adventitious ganglia, often seen on the back of the wrist,

mucous cysts, *e.g.*, surcharged Nabothian follicles about the neck of the uterus, or distended Cowper's glands just within the orifice of the vagina, the less fatty cysts, *e.g.*, certain wens, and seminal cysts in connection with the spermatic cord—encysted hydroceles. A collection of such cysts presents similar characters. The resistance of the circumscribed fluctuation varies in degree, from that of the most fluid, to that of the most solid-feeling thick fluid; as grumous blood, synovia, mucus, or the butter-like consistence of sebaceous cysts.

Subject to these original deviations, the typical condition of the cystic-growth is that of one or more membranous bags, filled with some kind of fluid; and as such, its physical characters supply a complete diagnosis. Any uncertainty as to its nature can be determined by puncturing the supposed cyst with a grooved needle or with a fine trocar and canula, and examining its contents, simply by inspection, or under the microscope.

Other conditions are subsequent productions:—

The *proliferous* development of a solid growth within a parent cyst, is especially observed in sero-cystic disease of the breast, and in cystic bronchocele. A tumour, originally fluid and fluctuating, is thus converted into an unbroken solid mass; but during this transitional change the growth, not yet completely filling the cyst or cysts, is immersed in fluid, so that the whole feels a mixed tumour—partly fluid, partly solid.

Ultimately, if one of the cysts should burst from over-distension, or if it be artificially laid open, the growth within, no longer restrained, increases, and protruding in the form of a fungus, gives to the tumour a new and characteristic appearance.

Varieties and Diagnosis.—A thickened cyst simulates the characters of other tumours. It may resemble a chronic abscess, *i.e.*, without the pain, heat, and redness of inflammation, only presenting swelling with fluctuation. But a pus-cyst, so to speak, is more blended with surrounding tissues,—it is less circumscribed than a cyst which has merely become thickened. An ordinary cyst is sometimes actually converted into a painless chronic abscess. Their diagnosis is then practically unimportant. Cystic parasites are of comparatively rare occurrence: cysticercus cellulosus and echinococcus hominis may appear in the cellular texture, the former as a small, the latter as a large cyst. Their nature may be ascertained by puncture, and an appeal to microscopic examination. Billroth has seen the cysts of the first-named parasite removed from the nose and tongue, and vesicles of echinococcus removed from the back and thigh. Trichina spiralis, also an encysted parasite, inhabits the voluntary muscles, and always in vast multitudes, appearing to the eye as white specks. But this cystic condition is perhaps beyond the reach of diagnosis, and certainly of surgical treatment.

(2.) Cystic-tumour.—A cyst or cysts within the substance of a solid tumour renders the diagnosis more obscure than when not so imbedded. Thus, cysts are, occasionally, set in the substance of a fibrous, fatty, or cartilaginous tumour, or in cancer-growth, and perhaps no kind of tumour is exempt.

The depth of integuments, underneath which a cyst may be situated, will more completely conceal its true character.

But the physical signs of cysts in tumours are constant. A circumscribed boundary, and fluid resistance, in some degree, to the touch,

invariably accompany the presence of a cyst or collection of cysts. (Fig. 32.) These characters are also peculiar; they point to no other kind of tumour or swelling, except in the cases adverted to.

Fig. 32.*

Situation.—Cystic growths—originating from the erring development of cells or nuclei—may occur in any texture or organ, but most frequently in the kidney, thyroid gland, mammary gland, choroid plexus, chorion; in the neck, gums, about the sheaths of tendons at the wrist, —forming ganglions; and about the epididymis, as seminal cysts, encysted hydroceles, or hydroceles of the spermatic cord.

Cysts having this origin are single, or numerous, in the same organ or part.

Origin.—Of Simple or barren cysts: the serous date from birth or earliest childhood, as by transformations of nævi; or from puberty or later life, as an ovarian tumour by enlargement of Graafian vesicles; or from perhaps still later life, as mammary cysts which begin during or after the time of natural degeneracy of the milk-glands. Of Proliferous cysts: the cutaneous which occur in or near the orbit, are congenital; whereas those which, as wens, occur in the scalp, are not congenital. They are, however, hereditary, though unconnected with any constitutional tendency.

* Cystic tumour of the femur. (After Pean.)

Cyst-formation, whether barren or proliferous.—Three modes of production are tolerably well established; but no accurate classification of these growths can be determined upon this ground of distinction. Cyst-formation is as follows:—

Firstly.—By the dilatation and coalescence of the spaces in cellular tissue, a rude cyst is formed, and afterwards finished off on its internal surface, which becomes smooth, and perhaps lined with epithelium. Thus are formed certain adventitious bursæ, *e.g.*, the little sac which Hunter first pointed out underneath the skin of an old corn.

The simple cyst fashioned from areolar tissue may acquire a proliferous power, as witnessed occasionally in adventitious bursæ, from the inner surface of which pendulous little polypi sometimes grow.

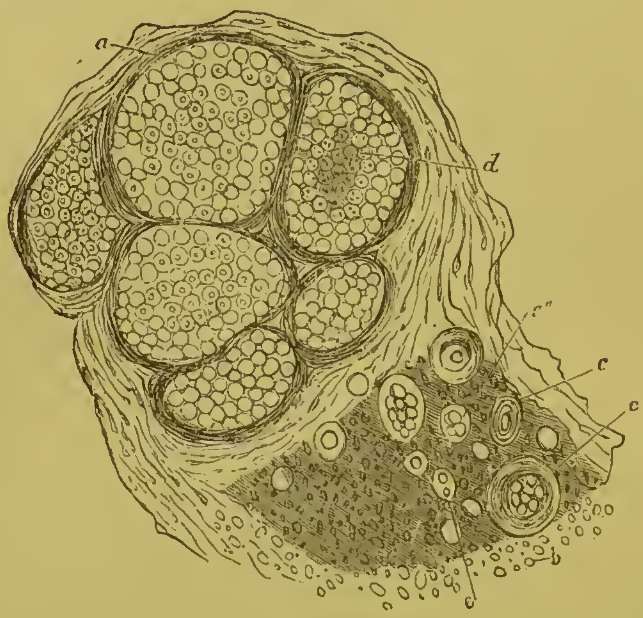
Secondly.—By the dilatation and distension of certain natural cavities are produced *retention*-cysts, so named by Virchow. The dilatation of gland-ducts may thus give rise to cysts. Of this kind of cyst are those sacculated enlargements of the lactiferous tubes, filled with milk or serum, which Sir B. Brodie first described as sero-cystic conditions of the mammary gland. But this disease is perhaps more usually due to another mode of cyst-formation, which I shall describe presently. So also ranula, a cystic swelling under the tongue, may result from the obstruction and dilatation of the duct of the sub-maxillary gland. Natural bursæ sometimes enlarge, and become distended with synovia. The bursa betwixt the skin and patella thus enlarged, and known as "housemaid's knee," is a familiar example. Mucous cysts, by enlargement of the Nabothian gland-follicles about the cervix uteri, or of Cowper's glands in the female, situated just within the vagina, are further illustrations of cyst-formation by dilatation and distension of a natural cavity with its own fluid. Fat-cysts are produced in this way, out of the sebaceous and hair follicles, forming common wens. Cysts of the sweat-glands are unknown. Graafian vesicles, by overgrowth, are evolved into ovarian tumours. I may here notice certain rare kinds of sanguineous cysts, which, from a case related by Sir James Paget, appear, as he says, to be "dilated portions of blood-vessels shut off from the main streams." Of sanguineous cysts having this mode of origin, one was removed by Mr. Lloyd some years since from a man's thigh. It lay in the course of the saphena vein, but neither that nor any other considerable vein was divided in the operation, or could be traced into the cyst. This cyst was of spherical form, about an inch and a half in diameter, and completely closed; its walls were tough and polished on their inner surface, it was full of dark fluid blood, and its venous character was manifested by two valves, like those of veins, placed on its inner surface. On one of these a soft-lobed mass, like an intra-cystic growth, is seated. The preparation is in the Museum of St. Bartholomew's Hospital.

This specimen teaches an important lesson; that a simple cyst formed by the expansion of a natural cavity, may become proliferous, a soft-lobed growth having sprung from the interior of the cyst; and this truth is confirmed by the proliferous power of the lactiferous tubes when enlarged in certain cases of sero-cystic disease of the breast, and the prolific growth of cells in the parent cysts of an ovarian cystic tumour.

Thirdly.—Besides these two modes of cyst-formation, another mode of production has been discovered, chiefly by the observations of Roki-

tansky, Frerichs, and Mr. Simon, respecting cysts of the kidney. It would appear that certain cells expand and develop themselves into larger cells, which aggregate together in "nests," each nest becoming enveloped with a thin capsule of fibro-cellular filaments, which thus forms a cyst containing cells.

FIG. 33.*



But the erring cells themselves may each acquire sufficient size to merit the name of a cyst. The cells which naturally inhabit the villi of the chorion, according to Dr. Mettenheimer, occasionally enlarge into cysts, and form the hydatid mole. From erring cells are sometimes produced serous cysts in the neck, in the thyroid body, in the gums, in the mammary gland, and a cystic condition of the choroid plexus. By this mode of origin, also, may be evolved certain sanguineous cysts, *e.g.*, in the neck; certain adventitious synovial bursæ, *e.g.*, ganglions formed in connection with the sheaths of tendons; and certain seminal cysts. (Paget.)

A surprising proliferous power is frequently manifested by cysts derived from erring cells, of which some instances of cystic diseases of the breast and other glands are probably illustrations. Associated with this power of growth and development, is the well-known fact that proliferous cysts frequently recur after, as it would appear, the complete extirpation of the original cyst. Sir James Paget relates a remarkable case of this kind, recorded by M. Lesauvages. The patient was sixty-three years old. The first tumour of the breast, of great size, was extirpated in February, 1832; a second appeared, and was removed

* Proliferous cyst-formations from the cortical substance of the kidney, as a sequel to Bright's disease.—*a.* The fibrous sheath in progress of development out of *d*, the elongated and caudate nuclei coursing around the parent cyst or aggregation of parent cysts. They eventually break up into the requisite fibres. *e* is to represent the point-molecule, within an amorphous blastema, out of which the nuclei (*b*) form. They are at first spherical, afterwards elongated, and ultimately broken into fibrillation. This constitutes the "alveolar type or arrangement." 90 diam. (Rokitansky.)

before the healing of the first wound; a third in May; a fourth in September of the same year; a fifth sprang up, and was removed in February, 1833; a sixth in the ensuing May; by a seventh operation, in June of the same year, three tumours were again excised; but from the same spot two more arose, which grew rapidly, and the patient died.

Course.—The vital career of cysts, and cystic tumours, is sufficiently indicated by the proliferous changes which cysts, originally barren, may undergo, and their issue, in the protrusion perhaps of the intracystic growth. The rate of growth of cysts, and the probability of their recurrence, when removed, or apparently obliterated, vary considerably.

Thus, of Simple or barren cysts; the serous and sanguineous observe no definite rule of increase, and neither, *per se*, are likely to return. A mucous cyst is more difficult to obliterate, and long after apparent cure, may fill again. Of Proliferous cysts; the cystigerous may be slow growing, as an ovarian tumour, and not liable to recurrence; so also cutaneous cysts, as scalp wens; but cysts proliferous with vascular growths, may grow rapidly, as in the mammary gland, and generally return, even repeatedly.

Treatment.—Cysts and Cystic Tumours are amenable to treatment, in accordance with the general indications, 1, 2, and 3. *Simple* or Barren Cysts, containing unorganized secretions of various degrees of fluid consistence, may be effectually reduced by absorption, destroyed, or removed, by one or other of the following modes of treatment:—

Stimulating applications, as the compound tincture of iodine, may induce absorption of the contents of the cyst; and if no re-secretion ensues, a cure will thus be effected. Puncturing the cyst, and drawing off its contents, followed by compression by means of a pad of lint and bandage, is also a curative proceeding of at least a temporary character. But the cyst is apt to fill again eventually. By this treatment, I succeeded for some time in controlling two large cysts deeply situated, one beneath the muscles of the calf, the other deep in the popliteal space. The diagnosis also, in these cases, was determined by the preparatory puncture. Puncture, and a stimulant injection, or the introduction of a seton, may succeed in obliterating the cyst by adhesion of its interior, or destroying it by sloughing, and in either way effecting a cure.

Excision of the cyst is a procedure available when other resources have failed, or more advantageously, in the first instance, before the textures have been tampered with by any other treatment. A cyst may have become converted into a painless chronic abscess. I once removed a large cyst, in this condition, from beneath the tensor-vaginæ and sartorius muscles, by an incision eight inches long. The man made a good recovery. In another case, I removed such a cyst from the axilla. Complete excision is rarely necessary to insure the non-recurrence of any simple cyst; a small portion left after operation, will granulate and cicatrize. But a cluster of cysts must be removed entirely; otherwise, any one remaining will afterwards continue to grow. Thus the whole mammary gland, if beset with cysts, must be sacrificed.

Proliferous Cysts.—Excision is the only sure and safe mode of treatment; removal of the cyst or cysts entirely, by the knife, being necessary to overcome the productiveness of any such cyst. Cystigerous,

and glandular, proliferous cysts, the latter especially, render this proceeding the more necessary. Cutaneous proliferous cysts also are more properly excised. The common scalp-wen, for example, in most instances; and the operation in this case is very readily accomplished. An incision having been made extending down through the cyst, either half can be seized with forceps and easily turned out of its bed, the cellular connection offering very slight resistance. Erysipelas is apt to follow this simple operation, in old or debilitated subjects. It may, therefore, be advisable in such cases, to remove the contents of the cyst by puncture, or even to destroy the cyst by sloughing. If the former mode of treatment; the introduction of a probe through the small black point existing in most cases, will permit the contents to be squeezed out of the sac, which may then be made to heal from the bottom, by the substitution of a few threads as a seton. Or if it be desirable to induce sloughing of the cyst, this can be effected by introducing a stick of caustic potash, and turning it about a few times, or by pencilling the skin over the tumour. In either way the cyst is laid open, when the slough separates, and heals from within. Nitric acid and other powerful irritants are useful for the same purpose.

Fatty Tumour.—*Structural Condition and Diagnostic Characters.*—This growth is of soft, doughy consistence, defined or circumscribed, deeply and largely lobulated (Fig. 34), and freely movable; sometimes shifting from its original locality owing to the looseness of its connection; often attaining to a large size and great weight, even to fifty

Fig. 34.*

Fig. 35.†

pounds; usually subcutaneous, and probably situated somewhere about the trunk, posteriorly; and solitary. It has the composition and general structure of ordinary fat—*i.e.*, fat-cells (Fig. 35), collected together, and imbedded in a fibrous mesh-work, more or less abundant, and resembling condensed cellular texture; this, however, is continuous with a thin fibro-cellular capsule enclosing the tumour; prolongations of which, penetrating the mass, separate it into lobes, while, externally, the whole investment is loosely connected with surrounding parts. Blood-vessels, collected mostly at one point of the tumour, pass into its substance from the cellular capsule. A cavernous dilatation of the veins has often been noticed by Billroth.

* Fatty tumour, removed from under the tongue; half-size. (Liston.)

† Structure of a fibro-fatty tumour.—*a*. Isolated cells, showing stellate crystals of margaric acid. (Bennett.)

Varieties and Diagnosis.—Occasionally, the cellular capsule is thick, dense, and fibrous. Its prolongations may also become fibrous and firm. The whole substance of such a tumour is hard and comparatively immovable, and although still circumscribed and lobulated, resembles a fibrous tumour. The *lardaceous* variety is of this description. Hard fibrous knots, as of the fibro-cellular stroma, or even bony nodules, can, occasionally, be felt within a tumour otherwise fatty. Or the mass may be, or become, softer than usual. Oleaginous fat, with but slight fibro-cellular partitions, presents the characters of a bag or cyst of fluid, and gives out the physical signs of a fluid encysted tumour. True cysts are, occasionally, developed in a tumour otherwise fatty; thus giving the consistence of roundish elastic bags of fluid set in a doughy substance. Still more rarely, suppuration occurs, centrally perhaps, within a fatty tumour, and forming a chronic abscess, simulates the character of a cyst.

Lastly, the characters of any such tumour, purely fat or mixed, may be obscured by the depth of integuments beneath which it lies buried.

But all these conditions are exceptional, and, excluding that of the occasional depth of the tumour, they are subsequent conditions also. Neither, therefore, will scarcely affect the exactitude and the earliness of diagnosis, by physical signs; the ordinary physical characters of fatty tumour being generally present, and exclusively indicating this kind of growth and no other morbid condition. *Steatoma*—a lard or suet-like variety of fatty tumour—is liable to occur in whatever part of the body this growth makes its appearance; but steatoma has been found in some parts more especially; among them, in the mesentery, testicle, and mediastinum. (Walshe.)

Fatty tumour is usually a solitary growth; but in exceptional cases, several may co-exist from two or three, up to as many as a hundred, or more. I have removed several small fatty tumours from the same person. They were subcutaneous; four in one arm, and one in the other.

Situation.—Fatty tumour most commonly occurs in the subcutaneous adipose texture, especially of those parts where fat normally abounds in the healthy state, and is liable to accumulate; as about the trunk, *e.g.*, on the back, neck, and shoulder; also over the buttock, the thigh, or abdomen; between the peritoneum and abdominal walls, escaping from which by the abdominal rings, it forms fatty hernia, so called. (Walshe.)

This kind of tumour occurs more rarely in synovial sacs, especially that of the knee-joint, or in the sheaths of tendons; and in such situations having a branched appearance, it forms the "lipoma arborescens" of Müller. Fatty tumour may be produced where fat is normally scanty, as beneath the hairy scalp; or, where fat is normally absent; as in the sub-mucous cellular tissue of the stomach, the intestine, the bronchi; in the sub-serous cellular tissue of the pleura or dura-mater, and beneath the investing membranes of the ventricles. Also in the substance of organs; especially in the lungs, liver, kidneys, and in bone "affected with osteoporosis and eccentrical atrophy." (Rokitansky.) Between the corpora albicantia and optic nerve, in one case. (Müller.) A fatty tumour, the size of a mushroom, was found between the arachnoid and dura mater, on the level of the fourth lumbar vertebra. (Albers.) One as large as a walnut, in the walls of the vena

portæ. (Andral.) In or under the tongue, this species of tumour has been known to occur. (Liston. Paget.)

Origin.—Fatty tumour is very rare in children, but not unfrequently begins in youth, though, growing slowly, it may be overlooked for many years; it may begin to grow at any later age, but very seldom appears first in old age. This kind of tumour scarcely ever seems to be hereditary. Sometimes it has so appeared after fever or some general illness, as to seem due to a constitutional cause. It is sometimes referable to local causes, as a blow, or, more commonly, frequent friction, as by a strap or band over the skin. But in the majority of cases, no good cause whatever can be assigned.

Course.—The influence of a fatty tumour is purely local and mechanical. The rate of growth is generally very slow, sometimes fitful, very rarely rapid. It does not return, even when partially removed. It is not liable to ulcerate, but I have seen ulceration of the skin, apparently resulting from weight and friction, in the most dependent part of a pendulous fatty tumour in the thigh.

Treatment.—Absorption of a fatty tumour is perhaps possible, under the influence of medicinal treatment. Thus, this kind of growth is said to disappear occasionally under the influence of liquor potassæ, administered in half-drachm doses, gradually increased to a drachm, and continued for a month or more. In one case, the tumour was sensibly diminished in size by this mode of treatment, which was originally tried by Sir B. Brodie.

Excision, as a rule, is the only successful treatment. It is rendered necessary by the large size to which a fatty tumour generally attains; and especially when the mass is so placed—which, however, is not generally the case—that by its further enlargement, it would encroach on important parts adjacent, thereby rendering the operation eventually difficult or impracticable. The freedom with which a fatty tumour shifts its place, owing to the loose cellular connections of its thin dry capsule, is an additional reason for timely performanee of the operation. I have thus had occasion to remove a fatty tumour from the cheek, from the shoulder overhanging the axilla, and from other situations. The operation itself, although perhaps extensive, is easily performed.

Dissection, even among parts of anatomical importance, is scarcely requisite. The lobulated mass rolls out of its bed or is easily detached, until some corner appears where the nutrient vessels enter. Hæmorrhage is inconsiderable, but when these vessels are divided, a ligature or two may be needed. Any small portion of the tumour left behind is immaterial, it eeases to grow. The portion of skin to be removed is not so extensive as would at first sight appear neeessary. Any small portion spoilt by prcssure and any superfluous portion, may be included in thc excision; but the remaining integument will retract and pucker up, after the operation.

Sarcomatous Tumours.—A large elass of tumours are comprised under thc common term Sareoma; including the Fibro-cellular, the Fibrous, the Cartilaginous, and their varieties; also Glioma, Myxoma, and Granulation Tumours; or, all those Growths, the structure of which consists of fibro-cellular tissue, *connective tissue*, in *various developmental* conditions. But although the term Sarcoma, known since the days of Abernethy, has been revived by Virchow, Billroth, and other eminent pathologists, and adopted in some surgical works; yet

it is a very indefinite term—Sarcoma ($\sigma\alpha\rho\xi$, flesh) implying only the physical character of fleshiness, and thus associating tumours otherwise widely different. Billroth himself acknowledges that they possess a very diverse histological structure—round-celled, spindle-celled, giant-celled, net-celled, alveolar, and pigmentary; further, that their vital or clinical course is widely diverse, comprising local or innocent tumours, recurring, and systemically infectious growths; and that there is no correspondence between the histological structure of sarcomatous tumours, and their clinical course.

Fibro-cellular tumour may be taken as the type of Sarcoma. As a tumour it is distinguished from polypus, mucous or cutaneous, chiefly by its relation to the adjoining texture. Both are over-growths; but, while polypus is merely an out-growth of fibro-cellular tissue, the same structure, as a tumour, is distinctly isolated by a capsular investment.

Structural Condition and Diagnostic Characters.—The mass, thus detached, is roundish, and of tolerably regular outline, usually deeply and largely lobed. Its chief physical character is a remarkably elastic

Fig. 36.*

tension, due to the structural resemblance of this tumour to dropsical cellular tissue, circumscribed. It may grow to great size and weight, perhaps forty pounds. Section shows a yellow surface, marked with white lines, which have an undulatory direction across the tumour, and may divide its substance into distinct lobes. (Fig. 36. Virchow.)

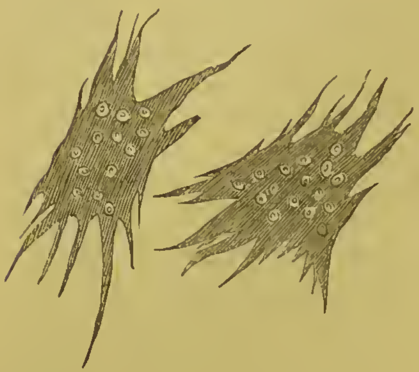
Fig. 37.†

* Section of sarcoma. (Virchow.)

† Large spindle-celled sarcoma. (Virchow.)

The yellow substance, the white bands, and the capsule, alike consist of fibro-cellular tissue, more condensed in the latter portions; but the whole is remarkably succulent, being infiltrated with a serous fluid, which exudes plentifully and continues to ooze from the cut surface.

Fig. 38.*



The tissue of which, together with the serous fluid, this tumour consists, represents an immature state of the normal fibro-cellular tissue. With many well-developed filaments, there are more abundant nuclei and cells forming fibres—spindle-shaped cells, or with filamentous prolongations, in various stages of development. (Figs. 37 and 38.) Yellow elastic tissue is very rarely present, unlike its frequency in ordinary connective tissue. Analogous as the texture of this tumour is to ordinary fibro-cellular tissue, it is, nevertheless, of rare occurrence, compared with other tumours—fatty, or cartilaginous—whose component textures are reproduced far less frequently than this tissue.

Situation.—Fibro-cellular tumour occurs most frequently in the scrotum, labium, or tissues by the side of the vagina; or in the deep-seated inter-muscular spaces in the thigh and arm.

As out-growths, some proceed from, and are connected with, the mucous membrances, forming polypi—*e.g.*, in the nasal passages, very rarely in the antrum; in the external auditory meatus; in the uterus, and urinary bladder. As cutaneous out-growths, they appear on the scrotum, prepuce, nymphæ, clitoris and its prepuce. In one instance, a fibro-cellular out-growth—which I examined with the microscope after its removal from the clitoris—was the size and shape of a large cocoa-nut. It weighed thirty ounces.

Fibro-cellular tumour, not out-growth, is usually solitary.

Origin.—This kind of growth may begin at any period of life, but most rarely before adult age, and most frequently at middle age or later in life. It is so seldom referable to inheritance, any general disease, or to violence, that any such relation would appear to be only a coincidence.

Course.—Portions of cartilage sometimes partially ossified, are occasionally produced in, or over, the tumour. Its texture may also degenerate. The rate of growth is variable; being very rapid, as much as three or four pounds a year—*e.g.*, in the scrotum; or more slowly increasing. Recurrence is very improbable, unless the tumour be unusually soft and succulent, and the fibre-cells in great proportion rudimentary.

Treatment.—Excision of a fibro-cellular tumour is the only effectual mode of removal. It becomes necessary owing to the increasing size of the growth. The operation cannot be accomplished with the same facility as that of a fatty tumour. Nevertheless, a thin capsule defines the lobulated mass, its connections are not very close, and the

* Giant-celled sarcoma. (Virchow.)

hæmorrhage is but slight compared with the size of the tumour. I have excised such tumours without any recurrence.

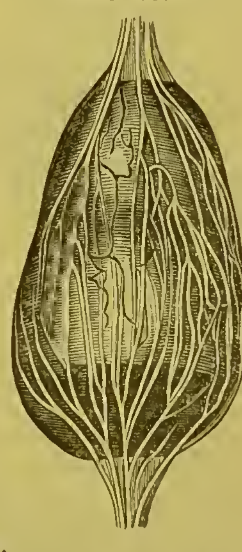
The largest fibro-cellular out-growth I have yet seen, that of the clitoris enlarged to the size of a cocoa-nut, was easily removed by a sweep of the knife through the peduncle.

PAINFUL SUBCUTANEOUS TUMOUR, or TUBERCLE—so named by Mr. W. Wood, who first described it—is a peculiar variety of fibro-cellular tumour, to which and to fibrous tumour it is structurally allied; but peculiar, if only as distinguished by the pain, intense and paroxysmal, which commonly occurs, and which is not to be accounted for by the structure of the tumour, itself perhaps destitute of any nerve-filaments, nor by any special relation to adjacent nerves.

This painful tumour, situated in the subcutaneous cellular tissue, is barely visible; for it is beneath the skin, and scarcely projects. It is also of small size, rarely exceeding half an inch in diameter; but it can be readily felt, as a roundish body, very firm and elastic. Isolated by a capsule, this hard body is free in the subcutaneous tissue, and is, therefore, so far movable; but it may be intimately adherent to the skin, and move with it when pressed under the finger. The superimposed skin, if adherent, has the general appearance of a cicatrix; it is slightly puckered, stretched, glistening and white, unless during a paroxysm of pain, when it may become congested and swollen, and the surrounding blood-vessels turgid.

The surface and section of this tumour are alike in colour variable; commonly yellowish; sometimes only greyish, or pure white. Its substance consists of fibro-cellular or fibrous tissue, with an abundance of nuclei intermixed; and the whole represents an immature state, or rather various immature states, of either tissue. Nerve-filaments have not been discovered. The tumour is usually solitary, as well as subcutaneous. It is thus also distinguished from Neuroma, a fibrous tumour connected with a nerve. (Fig. 39.) This latter species of growth is characterized by the presence of nerve-filaments in, or spread over, the mass; and by the large number of such tumours often produced in various parts of the body, not less perhaps than 2000 having been found in one unprecedented case. (R. W. Smith.)

FIG. 39.*



Situation.—Painful subcutaneous tumour or tubercle occurs, as its name denotes, beneath the skin; and especially in the extremities, more particularly the lower limbs, very rarely on the trunk or face. It has, I believe, been found deeply imbedded in the substance of muscle.

This tumour is solitary in nearly every instance.

Origin.—Painful tubercle is very rare in both early life and old age. It occurs much more commonly in the female than in the male.

Course.—Slow growth, and non-recurrence when removed entirely, characterize the life of this little tumour.

Treatment.—This variety of fibro-cellular tumour generally requires

* Neuroma. (After Follin.)

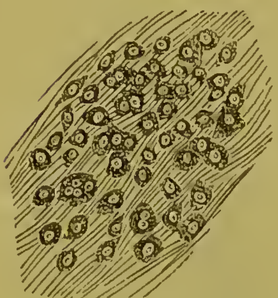
the same treatment as that growth. But excision is resorted to, and with the ready concurrence of the patient, to exterminate, so to speak, the otherwise excruciating paroxysmal pain in the tumour, rather than in consequence of any mechanical inconvenience by its size, which is always inconsiderable. The pain may perhaps be relieved, for a time, by firm pressure with a metallic ring placed on the circumferential portion of skin; but the tumour will ultimately have to be excised to obtain permanent relief from suffering. I am not aware that pain ever recurs in the cicatrix, although free excision may be advisable, as a precaution; assuredly the tumour itself never returns, when completely extirpated.

Neuroma is also amenable only to excision. The nerve-filaments, enclosed in, or expanded over, this little tumour, must generally be divided. Occasionally, the tumour can be dissected out of the nerve, leaving it intact. This more conservative mode of excision is especially important in the case of a large nerve, as the sciatic. But the presence of more than one, sometimes very many, neuromata in various parts of the body, may render any operation useless.

As a palliative, in both these forms of painful tumour, the topical application of the most benumbing anodynes, *e.g.*, the tincture of aconite, is worthy of trial. I have met with instances of fixed pain limited to a spot, at the junction of the ball of the thumb and wrist, and in other situations, where great relief has been obtained by the occasional application of aconitine ointment,—one grain to a drachm of lard. The best aconitine must be used; it was prepared by Messrs. Morson, of Southampton-row, who are justly celebrated for the preparation of this and other vegetable alkaloids.

Glioma.—A variety of fibro-cellular tumour is thus named by Virchow, from its originating in the neuroglia or connective tissue of nerves; but it contains no nervous element, only round cells of variable size—as in granulations (Fig. 40), or with offshoots, and an inter-cellular substance. Parts of the tumour may have undergone fatty or calcareous degeneration. Glioma may be soft, resembling myxoma or medullary cancer, or of hard consistence, like fibrous tumour. Section presents a vascular surface, translucent, and bluish-white or pinkish-grey. This tumour occurs at an early period of life, and more often forms in the eye than in other parts.

Fig. 40.*



Treatment.—Excision is the only cure; and recurrence is improbable, unless the cells are of large size.

Myxoma—so named by Virchow—or mucous tumour, originates in moist and soft connective tissue, and consists of a modification of that texture. (Fig. 41.) The substance of this growth is remarkably gelatinous, loose and juicy, like that of the umbilical cord, and on section it trickles away in thick gelatinous strings. Such tumours

Fig. 41.†

* Round cells of Glio-sarcoma. 350 diam. (Virchow.)
† Net-celled Myxo-sarcoma. (Virchow.)

may be found in the eye, or the brain; in the connective tissue of the nerves, in subcutaneous tissue, as near the angle of the jaw; or deep in the thigh, in the breast, or in the jaw. As a mixed tumour associated with other textural elements, as bone or cartilage, the growth may attain a large size, still of slimy softness, and situated perhaps in the septum of the nose.

Treatment by extirpation with the knife will always prove a permanent cure, when the locality of the tumour admits of complete removal.

Among fibro-cellular growths may be mentioned a rare species, named by Virchow *Psammoma;* a tumour containing brain-sand, and which forms only in the choroid plexuses and dura mater.

FIBROUS TUMOUR.—*Structural Condition and Diagnostic Characters.*—The great firmness and elasticity of this growth are peculiar; and less so, its spheroidal shape when uninfluenced by the pressure of surrounding parts, and its occasionally lobulated character. The tumour sometimes attain a large size and weight, even seventy pounds. Its chemical basis is gelatine, but the other constituents are unknown. On section, it commonly presents a greyish colour, sometimes a yellow, brown, or bluish tint, and variously intersected by white opaque lines; the surface assuming a convex form, like that of an inter-vertebral fibro-cartilage, owing to the elastic tension of the texture. It consists of the white, and perhaps the yellow or elastic fibres of ordinary fibrous tissue, which have an undulatory arrangement (Fig. 42); or a concentric disposition around distinct axes, with intermediate waving filaments; occasionally, a uniform aspect, without any marked fasciculation. Like fibrous tissue, it is but scantily supplied with blood-vessels, which pass into the substance of the tumour from a fibro-cellular capsule, conducted by thin unsheathing partitions, in the lobulated form of growth; and the capsular investment is more apparent around those tumours which are imbedded in solid organs. The vascularity of a fibrous tumour is generally inversely proportionate to its density. An abundant supply of vessels, both arterial and venous, may render the texture highly vascular, the veins perhaps forming a coarse, cavernous network. Nerve-filaments do not seem to enter into the proper substance of a fibrous tumour; but, according to Billroth's observations, the fibrous texture may form around nerves and blood-vessels, and thus both may occupy the centres of the concentric arrangement of fibres. Muscular fibres, of the unstriped kind, are sometimes associated with the fibrous tissue; and the tumour so constituted Virchow has named Myoma, or it may be called Myo-fibroma. Uterine fibrous tumour, especially, answers to this description, being a fibro-muscular rather than a purely fibrous growth.

FIG. 42.*

Situation.—Fibrous tumours are formed in connection with the fibrous or fibro-cellular textures; most commonly in the substance of the *uterus*, or in the fibro-muscular tissue of the ligamentous re-

* Uterine fibrous tumour, section, like polypus, but discontinuous with the substance of the uterus. (Paget.)

flexions of the peritoneum; in the ovaries, Fallopian tubes, or vagina (Walshe); in the interstitial fibro-cellular tissue of nerves. Connected sometimes with *bone*, and—like cartilaginous tumours—formed either in its substance, or between it and the periosteum. The jaws are most liable to this kind of growth. Connected with the dura mater, is another frequent situation. In the sub-mucous cellular tissue, "more particularly of the intestine, stomach, and œsophagus; now and then in that of the larynx" (Rokitansky); in that of the pharynx, the nares, the rontal and sphenoidal sinuses; in the sub-peritoneal and sub-pleural tissue (Walshe); in the subcutaneous cellular tissue, as in the lobules of ears, after piercing for earrings (Paget); in the mammæ, testicle, thyroid gland, thymus gland; in the arterial tissue; and indeed wherever fibrous or fibro-cellular tissue is normally present or most prevalent. As occurring in the substance of the heart of a child, six years old, a unique specimen is described by Luschka. (Virchow's "Archives," viii.)

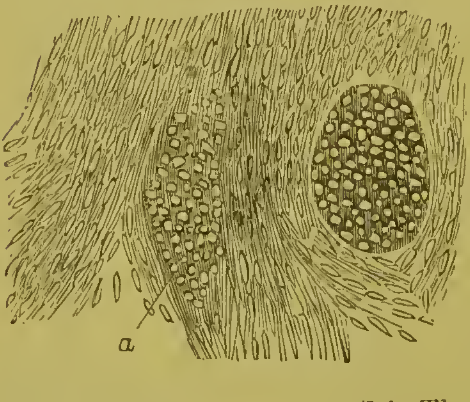
Fibrous tumour is usually a solitary growth; excepting in the nerves or uterus, in either of which several may co-exist. But when in the uterus, this species of growth rarely forms in any other part at the same time.

Origin.—This tumour rarely appears in youth, most commonly in middle age—thirty to fifty years—and very seldom in advanced life. The uterine fibrous tumour may have some physiological relation to the organ in connection with which it occurs. Sex seems thus far to have some predisposing influence. No hereditary tendency can be traced.

Course.—The influence of a fibrous tumour is purely local and mechanical. It may undergo softening, or serous infiltration. Ulceration of the integument of a superficial tumour is not uncommon, but the ulcer is quite healthy, and even disposed to heal. The rate of growth is slow, as compared with that of fibro-cellular tumour; but recurrence is equally improbable.

Varieties and Diagnosis.—Earthy matter or cysts may be found within the substance of this growth, and hence the terms fibro-calcareous and fibro-cystic, as designating these modifications. Other and more important varieties are recurring growths; the fibro-nucleated (Bennett), and the recurring fibroid. (Paget.) (*a.*) The *fibro-nucleated* variety presents the external appearance and general characters of an ordinary fibrous tumour, for which it might be readily mistaken. But the microscopic characters are those of the rudimentary white fibres of fibrous tissue, mixed with numerous large oval nuclei; thus representing a developmental condition of healthy fibrous tissue. (Fig. 43.) In point of course and tendency, the fibro-nucleated variety does not affect the lymphatics around, nor does it contaminate more distant parts; yet, when extirpated, it has a tendency to return, *in situ*. (*b.*) The *recurring fibroid* variety also, in its

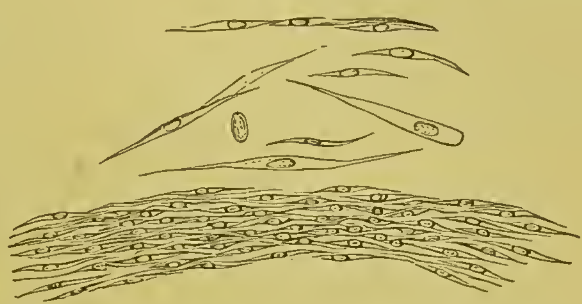
FIG. 43.*



* (*a*) Nests of nuclei, with interposed fusiform fibres, from section of a uterine polypus, boiled in dilute acetic acid, and dried. (Wedl.)

first stage, presents the external appearance and general characters of fibrous tumour. But in its minute structure it consists essentially of fibre-cells,—cells elongated and attenuating into white fibres, mixed with nuclei; thus representing another developmental stage of healthy fibrous tissue. (Fig. 44.) Not affecting parts contiguous or remote, the recurring fibroid variety has emphatically, as its name would suggest, a tendency to return again and again, *in situ.* Moreover, in this its second stage, it successively assumes the appearance of encephaloid cancer; having now become soft, bloody, and fungoid; but retaining its former structural characters, and vital significance, which is only somewhat less than that of encephaloid cancer.

Fig. 44.*



It will, therefore, be observed that the fibrous tumour, and recurring fibroid in its first stage, possess the same physical characters, conjoined with a different structure; and, conversely, recurring fibroid tumour, in its first and second stages, presents dissimilar physical characters, associated with the same essential structure.

Origin.—Both the recurring varieties of fibrous tumour usually begin between youth and middle age, very rarely either in childhood or in advanced life.

Treatment.—*Fibrous Tumour.*—Excluding this form of growth in the uterus, excision is still the only known remedy. Considering the large size to which the tumour sometimes attains, and especially the irregular shape which it acquires by adaptation to the parts around, the operation should be performed early. It is, however, accomplished less readily than that for a fatty, or even a fibro-cellular, tumour. Yet a thin capsule defines, and but loosely attaches the tumour to surrounding parts, from which it can be easily split; and the hæmorrhage is inconsiderable, as pertaining to the tumour. In connection with bone, the attachment is very close, and the basic portion of bone will probably have to be removed. Enucleation, or simply turning the tumour out of its bed, is available in some instances; chiefly for the removal of uterine fibrous tumours. Recurrence, after either mode of operation, is very improbable.

Recurring Fibroid, and *Fibro-nucleated Tumours.*—The treatment of both these recurring varieties of fibrous tumour is governed by the same general considerations. They are not influenced by any known medicinal agents, except perhaps the first-named variety of this growth. Iodide of potassium in large doses continued for several weeks, seems to have prevented the return of recurring fibroid tumour, in cases observed by Dr. Esmarch of Kiel. Excision is the only other resource. The size and often rapid growth of these tumours are urgent considerations. The operation must be freely performed, to insure, if possible, total extirpation of the tumour, which, however, is localized, though apt to return. Hæmorrhage may be profuse.

* Structural elements of recurrent fibroid tumour. (J. Birkett and Wilks.) Trans. Path. Soc. vol. vi.

The probability of recurrence is uncertain. Any such tumour may be removed, apparently entirely, an indefinite number of times, and each interval may be of longer duration, even to some years apart, after repeated operations; thus prolonging life, and granting successive periods of ease. Or, as is usually the case, this history may be reversed; more rapid growth, and shorter intervals of freedom, larger operations, progressive exhaustion and death.

CARTILAGINOUS TUMOUR.—ENCHONDROMA OF MÜLLER.—*Structural Condition, and Diagnostic Characters.*—This tumour presents the appearance, the chemical composition, and the structure of masses of fœtal cartilage. It is enclosed in a tough fibrous capsule, which conducts a few blood-vessels.

FIG. 45.*

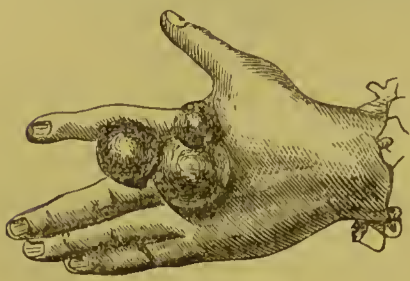


FIG. 46.†

The surface of a cartilaginous tumour is more or less irregular and lobulated, the fibrous capsule passing in between and separating the lobes; the whole mass varies also considerably in size (Figs. 45 and 46), from that of a pea to the bulk of a man's head, or growing even to enormous dimensions. Its substance is pulpy or more consistent, it may be hard, but elastic, crisp when cut, and a section is bluish-white, like London milk, glistening and translucent. These appearances, however, vary with modifications of structure.

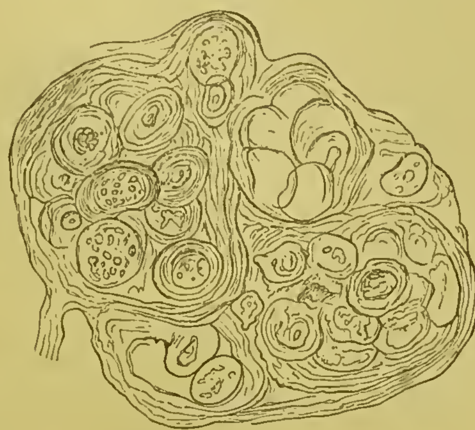
Two structural elements are found, the same as in ordinary cartilage; cells, and an inter-cellular substance, the latter being semi-transparent or molecular and dim, but more commonly fibrous. (Fig. 47.) The cells also may be scattered or aggregated, multiform, and they resemble either mature or rudimentary cartilage-cells. Their envelope is, therefore, more or less defined; it encloses one or more nuclei, within each of which is seen a nucleolus or two. Occasionally the nucleus appears radiated, not unlike the lacunæ and surrounding canaliculi of bone. There is, in fact, an intimate structural homology between the cartilaginous tumour and healthy cartilage, in its develop-

* Enchondroma of the hand. The tumours are drawn too regularly round, and have not the nodulated character of the cartilaginous tumour.

† Cartilaginous tumour of humerus. (Liston.)

mental conditions; and this resemblance extends to the myeloid variety of enchondroma. Blood-vessels, however, may be found permeating the inter-cellular fibroid matrix, which are not present in normal cartilage—a distinctive structural character. (Billroth.) The diversity of appearance presented under the microscope, by adjoining portions of the same enchondromatous growth, in regard to its structural elements, is peculiar to this kind of tumour among non-malignant or innocent tumours; a diversity of elementary forms which prevails in only one other kind of growth,—cancer.

Fig. 47.*



Situation.—Cartilaginous tumour is most frequently connected with the bones and joints; especially those of the hand, *i.e.*, phalanges and metarcapus; the corresponding bones of the foot, particularly the last phalanx of the great toe; the lower end of the femur, neighbouring end of the tibia; the humerus, scapula, sternum, ribs, ilium, and cranium. In the sheaths of tendons it has also been known to occur. Apart from bone and cartilage, enchondroma may form in the parotid gland, testicle, mammary gland, ovary, lungs, and in the subcutaneous areolar tissue. (Rokitansky.)

This kind of growth is not unfrequently solitary, excepting in connection with the bones of the hands or feet, where several may co-exist.

Origin.—In connection with bone, cartilaginous tumour begins most commonly at an early period of life; some, on the hands, in infancy, others, more often, between childhood and puberty. Their beginning in later life is, however, not very rare, even on the bones; and in other parts they commence, usually, in full adult or middle age. Inheritance, or injury, may have some influence in the production of this tumour, particularly when connected with bone.

Course.—The influence of a cartilaginous tumour is purely local and mechanical. The rate of growth is uncertain; generally slow, occasionally rapid; or the tumour sometimes develops rapidly after having been stationary for a period of many years. Recurrence is very improbable, unless in the case of a soft enchondroma.

Varieties, and Diagnosis.—The consistence of an ordinary cartilaginous tumour is liable to undergo remarkable changes. Fibrous transformation may be met with. A species of ossification sometimes takes place, beginning either on the surface or within the substance of the tumour. Again, the whole tumour may soften and feel like a fatty growth, or a mass of colloid cancer; or ossific nodules may soften and feel like a group of cysts. Such are the most important points of apparent resemblance between the cartilaginous tumour and other

* Cells, and inter-cellular substance or stroma, of a cartilaginous tumour, from the phalanx of a finger. Many of the cells are only drawn in outline; some of them present double or triple contour lines; most of the nuclei are large and granular. The groups of cells are intersected by bands of tough fibrous tissue. Magnified about 400 times. (Paget.)

growths. Lastly, associated with other growths, forming *mixed* tumours.

Myeloid tumour is allied to the fibrous by virtue of one structural element, the fibre-cell, and to the ordinary cartilaginous tumour by its more abundant many-nucleated corpuscles. (Fig. 48.) These corpuscles and imperfect fibres appear to be identical with those of healthy rudimentary bone. Hence, the marrow-like "myeloid" in substance, as so designated by Paget, has also been named "fibro-plastic" tumour, by Lebert, its structural elements resembling those of granulations springing from healthy bone.

FIG. 48.*

The external characters of the myeloid variety of cartilaginous tumour are tolerably definite. (Fig. 49.) Its surface is more or less lobulated. If enclosed within bone, its shape is uniform and spheroidal; if seated on the surface of a bone, its outline is irregular, as seen in epulis. The fleshy, inelastic firmness of a myeloid growth is remarkable, although its consistence varies. On section, the surface presents a greyish-white basis colour, daubed with irregular blotches of a bright red, livid or brownish tint. This blotched appearance is unconnected with any corresponding vascularity, the supply of blood-vessels being scanty even when the tumour is most ruddy. The cut surface is also succulent, and exudes a yellowish fluid.

FIG. 49.†

Situation.—Myeloid tumour selects bone more frequently than any other tissue. Paget has seen this growth in the mammary gland, and probably also in the neck near the thyroid gland.

Origin.—The tumour begins very rarely in early life, or in old age; most frequently between youth and middle age. It is seldom referable to inheritance, defective health, or injury.

Course.—The rate of growth is usually slow. Myeloid tumour is not apt to ulcerate or protrude like a recurrent fibroid growth; but it is liable, if not prone, to return when extirpated by the knife, thus differing essentially in its vital career from the typical form of cartilaginous tumour.

* Elemental cells of myeloid tumour.—A. Fusiform cells, or fibro-plastic cells. (Lebert.) B. Group of cells, each containing many nuclei. 350 diam.

† Myeloid tumour of the bones, in the elbow joint. A typical specimen. (Canton.) Trans. Path. Soc. vol. xiii.

Treatment.—Cartilaginous tumour must be removed by surgical operation. The functional inutility of the part, owing to the size, increasing growth, and relations of the tumour, will determine the necessity for interference; as in regard to other non-recurring and non-malignant Growths. But the size to which it may grow is scarcely so much a consideration, as the firm attachment of the tumour to bone, in the great majority of cases. Amputation, therefore, rather than excision is indicated. The performance of the latter operation is aided by certain circumstances. The mass, usually lobulated, is defined by a tough capsule investing the whole surface, excepting at the base of attachment. Within bone, this investment is complete. In either case, the capsule is connected to the texture around, by a dry connective tissue which can be more or less readily split up. The hæmorrhage is but slight, as occasioned by removal of the tumour, itself only sparingly vascular; and the surrounding textures are singularly healthy.

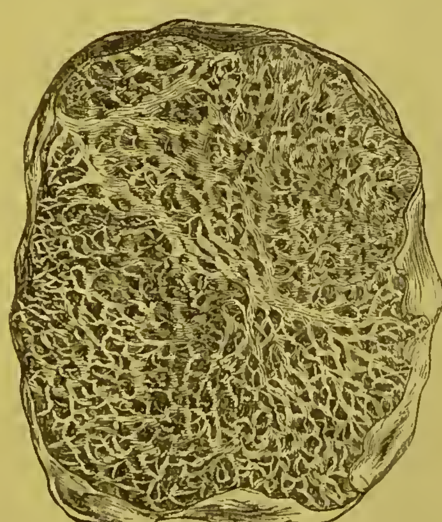
Enucleation of a cartilaginous tumour from within bone is, observes Sir James Paget, more often practicable than practised.

Recurrence need not be apprehended, otherwise than in exceptional cases. Any remnant portion of this kind of tumour will, according to Dieffenbach's observations, undergo ossification and become quiescent; but this result is uncertain. It should also be remembered that the part operated on may be rendered functionally useless, by the magnitude of an excisional procedure, or from tenosynovitis consequent on the interference with tendons in removal of the tumour. Thus, a finger subjected to such operation may become more useless than before.

Myeloid tumour admits only of free excision or amputation, and as a recurring growth is far less favourable for operation.

Vascular or Erectile Tumour.—*Angioma.*—*Structural Conditions, and Diagnostic Characters.*—This tumour essentially consists of a conglomeration of blood-vessels, connected together, more or less intimately, by fibro-cellular or connective tissue, which may form an investing capsule; the whole being thus circumscribed as a distinct tumour, but of irregular shape, and perhaps lobed (Fig. 50); or, the mass not being distinctly isolated, is diffused, flattened, and shades off into the surrounding textures. The size or extent of such a mass, in either case, varies with the species and its growth, and is subject to temporary alterations, under circumstances which will be noticed presently.

Fig. 50.*



Varieties.—Three varieties or species of this tumour are well defined, and easily recognised when formed in or under the skin. The constituent blood-vessels are capillaries, with arterial and venous

* Section of an erectile tumour—showing the fibrous trabecular structure, and investing capsule. (Hunter.)—Museum of the Royal College of Surgeons, England. Drawn one-third larger than the specimen.

trunks proceeding, respectively, to and from the mass; but either order of vessels may predominate, and constitute nearly the whole mass, apart from the connective tissue. Thus then there are the *capillary*, the *venous*, and the *arterial* varieties of vascular tumour.

The *first* consists almost entirely of capillaries—dilated, tortuous, and convoluted, as in "nævus maternus" or "mother's mark," also known as Telangeiectasis. The *second* is formed almost entirely of enlarged veins, or venous sinuses, embedded in a firm, fibrous network, —constituting a cavernous and erectile structure. This variety of vascular tumour was that which John Bell specially described, and to which he gave the name of "aneurism by anastomosis," or "aneurism by the dilatation of anastomosing vessels." The *third* variety consists almost entirely of arteries—enlarged, elongated, tortuous, and perhaps convoluted, and which freely communicate. *This* is now called "aneurism by anastomosis. (Fig. 51.) If the larger vessels are involved, it has received the name of "cirsoid aneurism." These varieties of structual condition are accompanied with corresponding peculiarities of *physical* characters, by which their *diagnosis* can be determined.

Fig. 51.

A vascular tumour is soft and compressible, but regains its former size when the congeries of vessels is left free to fill again,—the tumour is erectile. Its substance somewhat resembles a sponge; and if visible, as when subcutaneous or in the skin, the colour of this distended sponge plainly shows that it is full of *blood*, arterial or venous. The capillary and venous varieties are alike characterized by their circumscribed shape and soft doughy consistence, which can be moulded under the fingers; but at the same time a trembling sensation or *indistinct throbbing* is felt, if the mass for the most part be venous, and have attained some size. After compression, the tumour *slowly re-distends*, and assumes increasing size and tension during exertion, especially if sudden and violent, as in running, coughing, straining, struggling; and by any obstruction to the free return of venous blood. A *bluish* tint is perceptible when the tumour is situated superficially. Lastly, if wounded, the mass collapses. The arterial variety is chiefly distinguished by its *strong* pulsations, and threatening distension, increasing also under any occasional excitement of the heart's action, and with the flow of arterial blood.

Situation.—This species of tumour may be deep-seated; in muscles, in bone, the stomach, spleen, liver, kidney, supra-renal capsules, the uterus, in the brain, orbit, parotid gland, the tongue, and indeed wherever capillary blood-vessels naturally exist and most abound. The diffused form is more frequently situated superficially, as beneath the skin, and probably involving it; constituting the common cutaneous nævus, as seen on the scalp or the face.

Origin.—The vascular tumour is not unfrequently a congenital growth; it may be a subsequent formation, but more frequently in

childhood than in after years. Aneurism by anastomosis occurs mostly in children under fifteen, seldom in adults; and in an old person, Lisfranc knew of no instance of this form of vascular tumour.

Course.—The progress of growth is not generally steady, but by fits and starts; sometimes rapid, sometimes slow-growing. Very commonly, observes Paget, their increase is only proportionate to that of the rest of the body; and when full growth is attained, they also cease to grow. Not rarely they are stationary, or shrink, even while the rest of the body is growing; and this is especially likely to happen with those that are white and scar-like where the skin is involved.

The same author also notices certain structural alterations to which the vascular tumour is subject, by degeneration or by disease.

These morbid conditions disguise the original character of the tumour, and may now mislead the diagnosis. Thus, a vascular tumour may become converted "into a soft, but tough and dry yellow-ochre or brown substance, like that of a supra-renal capsule." Scar-like patches is another transformation, affecting the substance, or surface of the tumour, and accompanied with closure of the vessels in that portion. Acute inflammation may consolidate and cure; or, leading to ulceration, form bleeding sores, ill-disposed to heal. Either blood-clots, or phleboliths, sometimes partially consolidate; or cysts, serous or sanguineous, give a more elastic feel to the mass. More rarely, this kind of growth forms in another growth, and usurping its structure, converts part or the whole of such growth into a vascular tumour, and acquires its character. Thus, a cavernous enlargement of veins was noticed, as an occasional formation, in fatty and in fibrous tumours; while aneurism by anastomosis is often found in the substance of encephaloid cancer. Lastly, "it is probable also that one form of vascular tumour may be converted into another: a capillary one becoming either arterial or venous, by the excessive growth of one or other set of vessels; or an arterial one, by opposite changes, becoming either capillary or venous."

Treatment.—Vascular or Erectile tumours admit of treatment in accordance with each of the three general indications pertaining to morbid growths.

(1.) Absorption, by compression, steadily maintained by means of the air-cushion and spring. Compression is most practicable and effectual when the tumour rests on bone, thus supplying counter-pressure.

(2.) Obliteration, by cauterization, or injections, for the purpose of producing sloughing or consolidation of the tumour. Either plan of treatment is most appropriate for small vascular tumours, as certain nævi. In parts where the deformity occasioned by sloughing and cicatrization are unimportant considerations, cauterization, with the strong nitric acid freely applied to the integument covering the tumour, is perhaps warrantable. In parts otherwise circumstanced, as the face, the injection of some stimulant into the tumour is preferable, with the view of exciting inflammation short of sloughing, and thence consolidation of the tumour. Perchloride of iron may thus prove remedial, introduced drop by drop at different points, by means of a glass syringe, having a screw piston and a fine penetrating nozzle. Setons of silk, passed through various parts of the tumour, and allowed to remain in for some days, will, perhaps, more slowly produce the same result.

I have not had much experience in either of these, or similar modes

of treatment. What I have done or seen has led me to avoid such applications, as useless or perilous.

(3.) Removal, by ligature or incision. The former method is appropriate for vascular tumours *larger*, and, therefore, more arterial or venous, than those which can be safely obliterated by caustics or injections, or in cases where such treatment has failed. The advantages are—less liability to hæmorrhage, and a more healthy sore when the tumour is detached. The difficulties are—to include all the vessels connected with the tumour around its base, and to completely strangle without cutting them by the ligature,—thus insuring extirpation of the growth. But success is at least equally uncertain with regard to the treatment both by obliteration and absorption. Cessation of pulsation, or only a thrilling tremor in the tumour, and inability to reduce it by pressure, are signs that the operation of ligature has been effectually performed.

Excision is also applicable to vascular tumours of large size, especially those of a venous character, and those which are encysted. But the situations should be such as to allow of the parts being readily brought together after operation. Free excision is necessary, to prevent the risk of hæmorrhage, primary or secondary, and compression around will be an additional precaution.

NÆVUS.—This species of vascular growth in the skin consists of capillary vessels, enlarged, tortuous, and convoluted in the form of lobuli; involving the papillæ, the sudoriferous glands, the sebaceous follicles, the hair follicles, and extending down into the subcutaneous cellular texture, thus being seated both in and under the skin. But the vessels in either situation may be almost solely affected, forming the *cutaneous* and *subcutaneous* varieties of nævus. And the vascular growth may incline to the venous or to the arterial character.

The external appearances of nævus are commonly these: it is a vascular cutaneous spot, of a dark red or steel-blue colour, flattened, but somewhat raised above the skin; soft and compressible, painless, perhaps slightly pulsating under the finger, but disappearing on pressure, and returning when again set free; the vascular distension being increased by coughing, struggling, or any other effort which affects the circulation. Such a spot is usually congenital,—as a "mother's mark," it is situated generally on the scalp, face, or back of the neck, and varies in size from a pin's head to that of a half-crown, or larger. It is often single, but there may be two, three, or more vascular spots. Stationary nævi of this description are known as "moles." A less common form of nævus is that which presents a vascular patch of skin, having a deep red or claret colour, and extending over a large portion of the surface, as the side of the face, and perhaps down the arm and trunk.

Treatment.—When of small size, cutaneous, and not progressively increasing, a nævus may well be left to itself; and it may atrophy, wither, and disappear. When of large extent, although superficial, as on the face, presenting the appearance of a large purple patch; such nævus must be left alone, it is irremovable, albeit a great disfigurement. But, when nævus is of large size, or subcutaneous, and increasing in size, occasioning also much disfigurement; operative interference becomes necessary, and indeed urgent in proportion to the development of these characters.

Operations for the cure of nævi may be performed with a view either to their destruction and obliteration, or to their removal: (1) To induce adhesive inflammation in the substance of the tumour, with coagulation and permanent plugging of the erectile tissue; (2) cauterization, by the application of strong nitric acid or potassa fusa, in order to thus destroy the growth; (3) removal by incision, with the knife; or (4) by ligature, applied subcutaneously. *Adhesive inflammation*, as a means of destroying nævus, is eligible only when the tumour is of small size, and occurs in situations inaccessible for excision or ligature. Nævi situated near the eyelids, at the inner canthus, or on the tip of the nose, are thus circumstanced. Inflammatory adhesion and coagulation may be induced in various ways. By the injection of some stimulant, as perchloride of iron, by means of a screw-piston glass syringe, as used for the hypodermic injection of morphia; care being taken to throw in not more than two or three drops at one time, lest sloughing supervene, or coagulation extending into the surrounding vessels, a fatal embolism ensue from a clot entering the general circulation. Galvano-puncture is another mode of exciting coagulation and consolidation. Subcutaneous puncture, and division of the vascular tissue, by means of a fine tenotomy knife, is also an efficient, and a safe mode of destroying the tumour, in like manner. Or, by the introduction of seton-threads, for a sufficient time, and at different parts, in this way to induce inflammatory consolidation.

Cauterization is eligible for the destruction of nævus, where it is small and cutaneous, and its disfigurement is worse than the cicatricial scar resulting from the application of strong nitric acid or potassa fusa. Thus, a small "mother's mark," or an acquired vascular spot, may be touched with a glass rod dipped in the acid, or lightly pointed with a stick of the caustic.

Excision may be resorted to for the removal of large nævus, but this method will be appropriate especially when the growth is distinctly encapsuled, and can be dissected or shelled out.

Ligature, applied subcutaneously, is the other method of removal which must be had recourse to, in all other conditions of nævus, when of large size, not encapsuled, but connected with large feeding blood-vessels, especially arterial. The hæmorrhage attendant on excision would be dangerous or fatal, and can only be prevented or controlled by ligature.

Accordingly, the objects to be accomplished are—the complete and immediate strangulation of the vascular tissue, observing to include the whole tumour, and well around the limits of the disease; but avoiding the skin, which may be divided in the intervals of the ligatures, or a single ligature may be passed around the tumour, subcutaneously. Small, firm, round whip-cord answers best. The nævus-needles are curved, and firmly set in wooden handles, resembling aneurism-needles.

Nævus, of moderate size, and in a situation where cicatricial disfigurement is not of much consequence, may be ligatured by two double ligatures passed underneath the base of the tumour, and crossing in opposite diameters, so as to divide it into four sections; the skin may be either reflected, or divided circumferentially, in the intervals of the ligatures, which are then successively drawn sufficiently tight

around the base of tumour, and tied in a reef-knot. An ordinary nævus on a child's head, generally thus admits of ligature. (Fig. 52.) The tumour, when effectually strangled, sloughs in a few days, leaving an open sore, which granulates and cicatrizes.

FIG. 52.

Nævus of larger size, and so placed that the sacrifice of integument would entail much disfigurement, may admit of subcutaneous ligature; the skin being left entire in this operative procedure, and consequently not sacrificed by sloughing. The nævus-needle, armed with a double ligature, is introduced at some point of the base of the tumour, and carried round its circumference to the same point; the cord is drawn out into a single ligature, the needle withdrawn, and the two ends pulled steadily and tied tight enough to thoroughly strangle the included mass of vascular tissue. If the mass be so large, or so placed, that it cannot be thus encompassed by a single passage of the ligature, then the needle-point may be made to emerge at a convenient spot, one end of the cord drawn out, the needle withdrawn, and having been re-threaded with that end of the ligature, it is re-introduced at the point of emergence and carried round the remainder of the tumour to the point where it was first introduced; the operation being completed by strangulation and securing the ligature. A nævus on the cheek can be removed by this method, without any resulting disfigurement, more than a puckered appearance. I have known a dragging down of the lower eyelid to ensue, but this can be remedied by the operation for Ectropium. Ligature may be employed at an early period of life; in infants a month or two old, and with a successful result.

ANEURISM BY ANASTOMOSIS, consists of enlarged, elongated, tortuous, and perhaps convoluted arterial vessels, which freely communicate. The tumour or swelling has an ill-defined outline, and presented, when near the surface, a flattened but irregular aspect,—corresponding to the eel-like arteries (Fig. 51); and its distinctive character, as a vascular tumour, is its strong pulsations. This species of vascular growth is situated, most commonly, in the subcutaneous, or the sub-mucous cellular tissue; especially of the scalp, face, neck, or the orbit, and occasionally of the tongue. Or the tumour may be deep-seated, as in muscle or bone. Its origin—unlike nævus—is not congenital, but the growth commences usually in childhood; and it is sometimes referable to a blow or other injury of the part affected.

Treatment.—Ligature.—The tumour may be removed by ligature, either of the circumferential feeding branches, or of the main trunk of the part.

The former procedure has not been followed by successful results;

ten recorded cases having failed, without one single instance of ultimate cure. In two cases, however, where the scalp was the seat of aneurism by anastomosis, Gibson aided the effect of circumferential ligatures by incisions around the tumour in the intervening spaces; and this procedure proved successful.

Ligature of the main trunk has been practised on the carotid, when the tumour was seated on the scalp, or in the orbit; or the brachial, and femoral arteries, have been ligatured, when the disease occurred on the arm or leg. The carotid has been tied in twenty-three recorded cases; in five of which, both arteries were tied at intervals of several weeks. Single ligature proved successful in some of the cases; double ligature in all five. Ligature of the carotid for aneurism by anastomosis in the orbit, has been performed in thirteen cases; with a successful result in the majority.

These two procedures—ligature of the circumferential arteries, and of the main trunk—may be combined or practised in succession, and the former aided by the intervening incisions.

Other methods of treatment have been resorted to, but with less safety, or less success.

Excision—another mode of removing the tumour—has been practised, with previous ligature of the circumferential arteries. But the risk of hæmorrhage, primary or secondary, is considerable. Hence this operative procedure is suitable only in exceptional cases, where the tumour is of small size.

Obliteration, by adhesive inflammation, or perchance sloughing, is another principle of cure, which may be applicable in the case of a small-sized tumour. Thus the injection of perchloride of iron has been tried. But experience is wanting to determine the relative safety and success of this treatment.

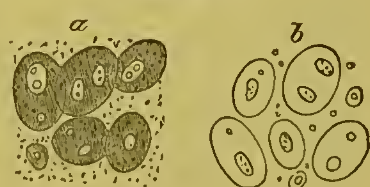
Direct compression may be mentioned, as it would seem an eligible mode of obliteration, when the tumour is so situated as to offer counter resistance to the pressure of a pad and bandages; *e.g.*, on the temporal or parietal bone. Yet compression has seldom proved successful.

OSSEOUS and GLANDULAR TUMOURS, respectively, are more properly considered in connection with Diseases of the Bones, and Glandular Organs.

INFILTRATING GROWTHS comprise, perhaps, only one genus—*Cancer:* its typical species being Encephaloid, Scirrhus, and, perhaps, Colloid, with many sub-varieties; distinguished chiefly by shades of difference in their general characters of colour, consistence, shape, size, and mobility.

Structural Conditions, and Diagnostic Characters.—The three species of cancer present under the microscope the same cell. (Fig. 53.) This, at first colourless and pellucid, consists of a delicate envelope, containing a large clear nucleus or two, sometimes more, never less, within each of which is imbedded one or two nucleoli, also large and clear. Such is the "cancer cell." (Bennett.) But is this cell peculiar to, and character-

FIG. 53.*



* Cancer-cells *a*, from scirrhus of the mamma. Transparent cells *b*, seen after the action of acetic acid. 250 diam. (Bennett.)

istic of, cancer? In considering the diagnosis of cancer, I shall have occasion to recur to this question. The cell assumes various shapes; either round, more usually caudate or spindle-shaped; and it presents other forms by outgrowths in one or more directions. (Fig. 54.)

FIG. 54.*

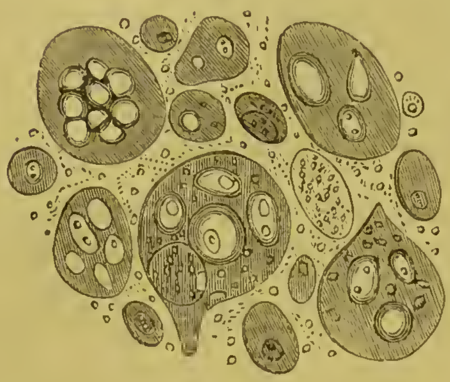


FIG. 55.†

These cells are deposited in a filamentous stroma or mesh-work, which has a variable locular arrangement and closeness of texture. (Fig. 55.) This inter-cellular stroma is probably, in most cases, nothing more than the fibrous tissue of the textures, amid which the cancer-cells are infiltrated. (Fig. 56.) But another inter-cellular substance—gelatinous, translucent, and amber-coloured—may be present in more or less abundance, and this is probably peculiar to cancer,—the colloid species.

FIG. 56.‡

The leading species of cancer are further allied by possessing a similar chemical basis; namely, chiefly albumen, associated with fibrin, gelatine, osmazome, fat, certain salts,—such as the phosphates and carbonates of lime, with the carbonates of soda and magnesia, the oxide of iron, and water. But the results of chemical analysis hitherto made are not very reliable.

Species.—As the *proportion* of cells, or of inter-cellular matter, prevails, so do we recognize *Encephaloid*, or cancer, *par excellence*, abounding with *cells;* and therefore *soft*, opaque, and of a dead white or fawn colour. Hence the terms cerebriform or medullary, applied to this

* Cancer-cells in the most advanced stage of development. (Bennett.)

† Section showing the arrangement of cells and fibrous stroma in scirrhus of the mamma. (Bennett.)

‡ Stroma of soft cancer, with partial infiltration of cells. (Rindfleisch.)

form of the disease; and—the cellular or special element of cancer predominating—encephaloid yields on pressure an abundant quantity of "cancer-juice," which resembles milk or cream. *Scirrhus*, on the other hand, is far more *fibrous*, and therefore *hard* and *craggy;* semi-transparent in a thin section, and of a bluish-white or fawn colour; comparatively little "cancer-juice" is exuded on pressing the cut surface of the fibrous stroma, and this little rather resembles thick gruel than cream, or it may be a small quantity of thin yellow serous fluid exudes; but the fibrous stroma itself contracts, whereby the cut surface speedily assumes a concave aspect, unlike the section of any other tumour, which remains level or becomes slightly convex at its margins.

Colloid—in contrast with both the foregoing—is *gelatinous*, owing to the predominance of the gelatinous, intercellular matter, and in which the cells are suspended, the whole being infiltrated through a delicate fibrous stroma: it appears, therefore, either as a trembling mass, or a glairy fluid, dimly transparent, and of a greenish yellow colour.

Cancer is essentially an *infiltrating* growth; but while this peculiarity almost constantly prevails in scirrhous and colloid cancers, encephaloid becomes *encysted*, about as frequently as it remains free. A very thin, yet distinct fibro-cellular capsule may invest this typical form of cancer, and from which thin partitions pass into the tumour thus defined, intersecting its substance, or investing its several lobes. Generally speaking, this capsule is not adherent to the surrounding textures; it furnishes a *matrix* in which numerous and tortuous blood-vessels ramify, previous to supplying the mass itself with vessels. Encephaloid is, indeed, always abundantly vascular, as compared with scirrhous and colloid, both of which are relatively destitute of blood-vessels. Lymphatic vessels have been shown by injection in medullary cancer, according to the observations of Schroeder van der Kolk, with regard to specimens of this species in the stomach and liver. Nerves probably exist in the substance of a cancerous tumour; for pain is felt in scirrhous, and less so in encephaloid cancer, when cut into during a surgical operation. This sensibility may be due to the nerves of the part, involved in the cancer-growth. But the question of nerve supply, in point of origin, proportion and distribution, has yet to be demonstrated anatomically, by dissection.

Tumour.—The investing capsule, when present, gives a definite outline to an encephaloid tumour—round, oval, spheroidal, or lobed, which contrasts with the irregular and unbounded outline of scirrhous and colloid, the infiltrating course of which is very rarely circumscribed. The boundary of either of these species of cancer is perceived rather by their degrees of consistence, as compared with that of the textures around the seat of infiltration.

The greater vascularity of encephaloid, coupled with its *capsular* and therefore more isolated condition, in many cases, are circumstances favourable to a corresponding rapidity of growth, and evolution as a distinct tumour; consequently this, the typical species of cancer, frequently attains an enormous size and protrudes (Fig. 57): whereas scirrhus, being differently circumstanced in these respects, remains smaller, rarely acquiring a larger size than an orange, and this rendered indistinct by infiltration of the surrounding textures. It shrinks yet smaller by their condensation and absorption, as its abundant fibrous

stroma, continuous with parts around, draws texture after texture within the claws, as it were, of the infiltrating mass. (Fig. 58.) Infiltration penetrates onwards, while contraction pulls backward; so

Fig. 57.*

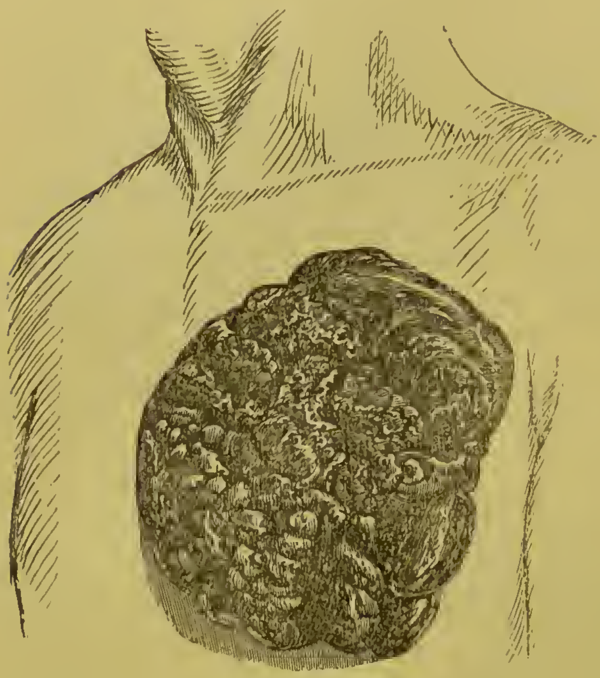


Fig. 58.†

that there is a double action at work—like the pulling on of a glove. Colloid cancer, although ill-provided with blood-vessels for rapid growth, is scarcely restrained by a contracting fibrous stroma, and—in this particular resembling encephaloid—it spreads to an indefinite size, but not as a distinct tumour.

The circumscribed, or non-circumscribed, condition of cancer much affects its mobility as a distinct tumour. Encephaloid is often distinctly movable in the organ or textures in which it is imbedded; while scirrhus and colloid can be moved about, only as a diffused mass in connection with those textures to which the cancer has contracted adhesion by infiltration.

Such are the chief peculiarities respecting the shape, size, and mobility of the three typical species of cancer—in addition to their individual properties of consistence (and colour); and by the concurrence of which characters they can be recognised during life.

Diagnosis of Cancer.—No sufficiently exact *structural* differences have as yet been detected, by which to distinguish these species of cancer-growth; we are, therefore, compelled at present to rely solely on their physical characters to determine the question of their (*differential*) diagnosis, so far as these characters can be recognized through superimposed integuments.

This conclusion refers only to the *comparative* value of structural

* Advanced carcinoma of the mamma,—exhibiting a prominent, fungoid, and bleeding mass. (Cruveilhier.)

† Scirrhus of breast.—Section showing contraction of nipple.

characters; for many other circumstances associated with cancer—its seat, character of the pain, influence of the growth on surrounding parts, the constitutional symptom of cachexia, course, and duration of the growth, and the peculiarities of age, sex, previous diseases of the individual, and hereditary taint—combine to regulate the diagnosis. All these elements will be more conveniently considered in the Vital History of Cancer.

But the structural *individuality* of *cancer-growth*, as a distinct kind of growth, is itself uncertain. The supposed characteristic "cancer-cell" is occasionally absent in tumours, otherwise cancerous; and similar cells may be found, and as often—according to Foster—in healthy as in diseased tissues, and are, therefore, not peculiar to cancer. These two propositions, taken together, *apparently negative* the value of the "cancer-cell," as the most exact ground of identification. Excluding, however, those *exceptional* forms of growth which simulate cancer in their clinical history, but which do not present the cells of cancer; and excluding also those *exceptionally* healthy tissues with which similar cells are found; this structural element is the most unequivocal sign of the presence of cancer.

In not a few cases, I have thus clearly demonstrated the nature of a cancer-tumour, by puncture with a grooved needle and submitting the material withdrawn to microscopic examination.

The three species—encephaloid, scirrhus, and colloid—may possibly co-exist and be combined in the same growth. Of this association I once saw a remarkable example in the *post-mortem* examination of a patient, who had been under the care of one of my colleagues at the Royal Free Hospital. The abdominal viscera were literally agglomerated into an enormous mass of cancer, which consisted of the three cardinal species above mentioned. A beautiful wax model is preserved in the museum of the hospital. Then, again, these species of cancer may succeed each other, as well as co-exist, in the same individual. Yet, with all this fraternization, they never lose their individuality; they never become transformed.

Varieties.—Many varieties of cancer have been described, which are worthy of notice, not because they possess any *essential* importance, but owing to the uncommon appearances they present, at least on examination as pathological specimens, and which may verify the Surgeon's diagnosis, after removal by operation. Like the typical forms of cancer, their varieties also are, in most instances, occasioned by different proportionate quantities of their constituent elements—the cancer-cells and fibrous stroma. Some of them, however, are occasioned by morbid changes of structure; degeneration, and the consequences of inflammation. They are all, severally, distinguished and recognized by their *physical* characters, which have suggested appropriate names.

The varieties of *Encephaloid* are—"mastoid" cancer, so named from its resembling, on section, the boiled udder of the cow. This term was originally proposed by Abernethy. "Solanoid" cancer resembles, on section, a sliced raw potato. It is hard, almost homogeneous, pale yellow, and crisp; hence this name, which was first suggested by Recamier. The substance of such a mass yields milk-like fluid in abundance, under pressure, and eventually softens. The "milt-like" tumour, so named from its general resemblance to the milt of certain fishes. (Monro Tertius.) "Nephroid" cancer exhibits, on

section, a peculiar arrangement of the fibrous stroma, and a semi-transparent watery glossiness, with other characters, not unlike those which the section of a kidney presents; whence its name. (Recamier.) "Fasciculate" cancer is another variety suggested by the peculiar appearance of its fibrous structure. (Müller.) The co-existence of softness, and linear or fibrillar arrangement, constitutes its most readily ascertainable peculiarity. (Walshe.) "Hæmatoid" cancer is a modification of encephaloid, in which the brain-like character is associated with an unusual amount of vascularity, the vessels sometimes interlacing so as to constitute a dense and somewhat spongy network, without, however, the peculiar structure of erectile tissue. "Fungus hæmatodes" is rather an advanced stage of encephaloid, than a variety of this species of cancer. It represents the occurrence of interstitial hæmorrhage, which either infiltrates the whole mass, or forms irregular accumulations of blood in its substance; and ulceration of the integuments taking place, a fungoid bleeding growth protrudes. "Villous" cancer is a term somewhat expressing the appearance presented by this form of encephaloid. It is very vascular, and apt to bleed copiously. This and its other characters are well marked when the disease occurs on the mucous membrane of the urinary bladder. It is described by Rokitansky as "dendritic vegetation;" an excrescence consisting, in its stem, of a fibroid membranous structure, on which the branches and villous flocculi are borne, as larger and smaller pouch-like and flask-shaped buddings, or sproutings of a structureless hollow tissue. "Melanotic," or melanoid cancer, is, with very rare exceptions, medullary cancer modified by the presence of black pigment in its elemental structures. This is a species of degeneration; besides which, encephaloid is subject to fatty and calcareous degenerations. Other morbid changes are suppuration and sloughing, which it is very liable to undergo.

The varieties of *Scirrhus* are—so-called "Chondroid" cancer, which is an early stage of scirrhus, dense and crisp; exhibiting, on section, an unusually shining aspect, and bluish-white colour. (Recamier.) "Lardaceous" cancer is occasioned by the infiltration of scirrhus through the substance of an organ, which then frequently appears not unlike the boiled rind of bacon. "Napiform" cancer is so named from the peculiar arrangement of its fibrous stroma, which, on section, has some similarity to a cut turnip. (Recamier.) "Apinoid" cancer derives its name from the striking resemblance presented, on section, to the cut surface of an unripe pear. This similitude arises from the dissemination of comparatively opaque and almost buff-coloured spots through a translucent ground of very pale yellowish-lilac tint. The quantity of more opaque substance gradually increases, and eventually predominates, so as to alter the appearance of the surface completely. (Walshe.) Allied, is the "reticular" cancer of Müller. "Hæmatoid" scirrhus is a condition of rare occurrence; but when it does happen, its peculiarities are of the same kind as those of the hæmatoid variety of encephaloid; differing only in being less fully developed. (Walshe.) "Osteoid" cancer, or ossifying fungus growth (Müller), occurs as a tumour, consisting chiefly of bone, but having on its surface, and in the interstices of its osseous parts, an unossified fibrous constituent, as firm as fibrous cartilage; after a time, similar growths ensue in parts distant from the seat of the first formed, and not on bones alone, but also in the cellular tissue, serous membranes, the lungs, lymphatics, etc. It

would appear to be the calcareous or osseous degeneration of scirrhous, or of medullary cancer, with which it not unfrequently co-exists. Uninterrupted gradations may be traced between the osteoid variety and these typical forms of cancer. Scirrhus is subject to other species of degeneration, and to morbid changes in common with encephaloid. Ulceration is more frequently observed in the course of scirrhus.

Colloid cancer is singularly exceptional in not presenting varieties, properly so called. Nevertheless, the quantity of fibrous stroma, or of colloid matter, may respectively predominate. If the former, then this species assumes the appearance of a very tough, white, fascia-like mass, in which are small separate cysts or cavities, filled with the colloid substance. In the opposite extreme, large masses of colloid matter appear to be only intersected by fibrous white cords or thin membranes, arranged as in areolar tissue, or in a wide-meshed network. Another variety refers to the *quality* of the colloid matter, rather than its quantity. It may be, or become, white and pearly, or opaque. I once met with a remarkable specimen of colloid cancer, in a female patient at the Royal Free Hospital (1862), and which I carefully examined. Most of the abdominal and pelvic viscera were affected with this disease; namely, the stomach; the intestinal canal, which was beset externally, here and there, with pedunculated masses of colloid, somewhat resembling plums on their stalks; two colloid masses were imbedded in the spleen; the pancreas was wholly converted into the same gelatinous substance, enclosed in loculi; the bladder was distended with a trembling mass, which rolled out like a jelly, leaving the mucous membrane pulpy, ragged, and bloody. The substance of the uterus and ovaries was infiltrated with drops of colloid, together forming a mass which seemed to be incorporated with a similar condition of the rectum. The gelatinous matter thus extensively diffused, was in some parts white, and of brilliant pearly transparency, looking like colourless and clarified jelly throughout the pancreas, white and opaque in the spleen and uterus; while it presented its usual amber colour and transparency in the other organs I have specified. This *opacity* of the colloid matter was probably due to molecular disintegration.

Such are the principal varieties of each of the three typical species of cancer. Some of them are, as I have said, the result of certain *morbid* changes, to which cancer itself is liable; they are illustrations of a pathological law which prevails extensively—that morbid products themselves undergo morbid changes—the diseases of diseases. Hence their almost numberless, and sometimes perplexing, complications.

Cyst-formation.—A further illustration of this law I have yet to notice in relation to cancer. This production, if not one of accidental association, represents an actual substitution of cyst-formation for cancer-growth, and at the expense of its own structural elements. Thus cysts may either be formed with cancer; or from and out of the cancer-structures, by their erring development and growth.

Sir James Paget's work contains the best summary of this subject, of which the following is an abstract:—

(1.) Respecting cysts accidentally associated with cancer, but of *independent* formation.

Scirrhus of the mammary gland may occupy a portion of it only, in the rest of which many cysts may be formed, that are in no sense

cancerous; or, the chief lactiferous tubes may be dilated into pouches or cysts, contiguous to, but quite independent of, the neighbouring cancer-growth. Such a cancer may nevertheless in its course enclose these cysts, and they remain for a time imbedded in its substance. The ovary may be the seat of cysts, and also the seat of cancer; the two growths thus accidentally associated, will probably become connected, although of independent origin. Further than this, cancers may grow from the *walls* of common cysts, *i.e.*, of cysts which have not originated in cancer-structures. Medullary cancer, especially the villous form, sometimes grows from the walls of cysts which have themselves no cancerous appearance.

(2.) Cysts *derived from cancer structures*—by their erring development and growth—constitute a series parallel with that of the cysts barren and proliferous, which form in innocent tumours, or in the natural textures. Cancer-cysts having this origin, are, therefore, either barren or proliferous.

Of the *barren* species are:—Cysts filled with serous fluid, variously tinted. Serous cysts are often born in cancers, especially in those of the medullary type, which grow quickly, or to a great size. One or many such cysts may be present on the surface or in the substance of a cancer. Sometimes a single cyst of this kind enlarges so as to surpass the bulk of the cancer, exceedingly perplexing the diagnosis. Sometimes many cysts are present, as if the tumour were entirely composed of them, with cancerous structure only in their interstices. Sanguineous cysts are born as often as serous, in medullary and other cancers. The imprisoned blood undergoes changes in respect of colour and consistence, thereby diversifying considerably the appearances presented by cancers containing these cysts. Colloid cysts, *i.e.*, cysts containing a glairy jelly—not cancerous—may likewise be developed in cancer-growths, by conversion of their structural elements.

The *proliferous* cysts which originate in cancers, bear on their inner surface cancerous growths—thus corresponding with the glandular growths which spring from the interior of cysts in the mammary and thyroid glands. These endogenous growths are often found in the alveoli of colloid cancer. Clusters of clavate, or flask-shaped villous processes, resembling those formed in the early stages of "dendritic vegetation" of villous cancer, spring from the wall of the alveolus.

The *origin* and *modes* of *development* of these cysts—simple and proliferous—have been traced by Rokitansky, and shown to correspond with those of all other cysts; the only difference being the *source* of the cyst-formation—here a cancerous element, while in respect of all other cysts it is an element of some natural tissue.

Situation.—The preference of Cancer for different tissues and organs, ranges according to the following average scale. (Rokitansky.)

"First, the uterus, the female breast, the stomach, the large intestine, and especially the rectum; next the lymphatic glands, especially as retro-peritoneal cancer-accumulation in front of the vertebral column; hepatic, peritoneal cancer; bone-cancer; cancer of the skin, and of the lips; of the brain; of the globe of the eye; of the testes; of the ovary; of the kidneys; of the tongue, and the œsophagus; of the salivary glands and parotid;" to which I may add—without pretending to determine their relative places in the scale of frequency—cancer

of the urinary bladder, of the pancreas, and of the spleen; in each of which organs I have seen, as already described, masses of colloid. In the remarkable case referred to, other organs were similarly affected: the stomach, intestinal canal, uterus, ovaries, and rectum.

This scale does not specify the particular *species* of cancer, in each of the different tissues and organs named; yet their relative liabilities in this respect is a matter of great practical importance, considering the unequal degrees of "malignancy" evinced by the several species of this growth.

(1.) *Encephaloid* cancer—the *most* malignant species—selects first, in order of frequency, the *testicle;* next, the *bones* and particularly the femur; the intermuscular cellular texture of the limbs; the *eyeball* or orbit; the breast; the walls of the chest, or abdomen; the lymphatics. Moreover, encephaloid "occurs in organs in which no other cancer, least of all scirrhous, ever occurs,—as in the liver, the kidneys, the lungs, the testicle, the lymphatic glands." (Rokitansky.)

Encephaloid cancer is *not* usually *solitary.* It commonly co-exists in many textures and organs.

Melanotic cancer—mostly a variety of encephaloid, by pigmentary degeneration of its cells, and the most common of all melanotic tumours —is prone to grow first, in or beneath pigmentary moles (Paget); or selects first the *liver* (Rokitansky); but it may occur "in the brain and about the nerves; at the eyeball, in the lungs, thyroid gland, liver, spleen, kidneys, bones, lymphatic glands, ovaries, in and beneath the intestinal mucous membrane, between the mesenteric layers, in the skin and subcutaneous areolar texture, upon serous membranes, in the dura mater, upon and within the heart."

This variety of cancer occurs as secondary formations, in very many textures and organs, simultaneously.

Villous cancer—another variety of encephaloid—is produced, according to Rokitansky, exclusively upon membranes; more especially upon mucous membranes, and most of all that of the male *urinary bladder*, near the opening of either ureter; next to this the mucous membrane of the stomach, and in particular the pyloric portion. It has been observed suspended by a pedicle from the internal membrane of the rectum, and even from that of the gall bladder. Secondly, it is very apt to grow extensively from the internal wall of ovarian cysts—cysto-carcinoma—where it is recognised as villous cancer by its copious accompaniment of medullary sap. In these cases, it is often concurrent with cancerous infiltration of the lymphatic glands about the lumbar vertebræ, and with peritoneal cancer—representing villous cancer upon a serous membrane. It has been observed also upon the dura mater; occasionally upon the general integument; and perhaps in bone. Lastly, it occurs in parenchymatous organs.

(2.) *Scirrhous* cancer selects first the *breast* in the proportion of 95 per cent. (Paget.) Next in order of frequency, the *stomach;* perhaps still more frequently, in this organ (Rokitansky); then, according to the last-named authority, the colon in its sub-mucous cellular tissue; more rarely in the vaginal portion of the *uterus;* upon serous membranes, and in the sub-serous areolar tissue. Again, as an expansive degeneration of the omentum, and of the mesentery; in the salivary glands; in the fibrous tissue of the bronchi. In several of these, as well as in other structures,—for example, the ovaries and the brain,—

there occur "cancerous growths of embryonic composition, and in all likelihood of fibro-cancerous (scirrhous) nature." To this list may be added cancer-growths *secondary* to scirrhus, and which, in proportion as they are consecutive, incline more and more to the condition of encephaloid; for example, of the lymphatic glands, the bones, muscles, skin.

Schirrous cancer is not unusually *solitary*.

(3.) *Colloid* cancer selects the *stomach* and *large intestine*, the serous membranes, and particularly the peritoneum. In other textures and organs this species is mostly *secondary;* as in the lymphatic glands, the lungs, the ovaries, the bones, the breasts; "and in rare cases, the kidney, uterus, and liver" (Rokitansky): to which I may add, the pancreas, spleen, and urinary bladder.

Colloid cancer is usually *solitary*.

Vital History of Cancer.—*Causes.*—*Age* has no definite influence on the production of Cancer; the three species having been known to originate at every period of life. Even during intra-uterine life, scirrhus in the heart was found in one case. At birth, meningeal cancer, and instances of cancer affecting other organs, have been found. In infancy, childhood, maturity, middle age, the decline of life, and extreme old age—even at ninety-three—cancer is liable to occur. But certain periods of life are prone to cancer-growth, as indicated by its mortality; the tenth to the fifteenth year is least liable, the thirty-fifth to the eightieth year, and perhaps to a later period, is most liable, the tendency increasing with each succeeding decennial period. There seems to be a more rapidly increasing tendency after thirty and onwards for some years, as compared with the same number of years before that period; the proportion of deaths, in both sexes, from the age of thirty to forty increasing to six times more than between twenty and thirty.

Sex much affects the liability to cancer. Thus, from forty to fifty years, in females, the mortality increases sixfold; whereas, in males, the number of deaths increases only two and a half times.

Sex in relation to *Species.*—Scirrhus is more common in the female, as affecting the breast; encephaloid occurs more commonly in the female, as affecting the uterus; but exclusive of this organ, men are more liable than women; colloid is of about equally frequent occurrence in both sexes (Lebert); but epithelial cancer is most frequently met with in the male.

Age in relation to *Species.*—Encephaloid occurs more often in infancy and youth; scirrhus in adults, it being uncommon before puberty or even the thirtieth year; colloid in adults only, or excessively rarely, if ever, before the thirtieth year.

Hereditary tendency.—Evidence in this direction may be resolved into two general facts. In some families cancer is known to have occurred in more than one individual. Mr. Sibley traced it among cancer patients at the Middlesex Hospital, in one case of every nine; Sir James Paget, in one of every six cases. Mr. Arnott and Mr. De Morgan each had charge of members of a family in whom disease was thus exhibited; the father and his relatives were healthy, the mother died of cancer of the breast, two of her sisters of phthisis, and one of dropsy. Of six daughters, five had cancer of the breast, the youngest was still healthy, and the only son died of phthisis. On the other

hand, to give some force to such observations, some *entire* families are exempt from the disease.

Hereditary tendency in relation to *Species*, is about equally influential in the production of scirrhous and medullary cancer.

Constitutional tendency to cancer can only be inferred—yet the inference is strong—from the apparently negative relation of this disease to any *external* causes. The various presumed external causes of chronic maladies shall continue in operation in many individuals, for a length of time with every degree of intensity and in all possible modes of combination, *without* producing the slightest manifestation of cancer; and cancer exercises its most fearful ravages in persons who have never been influenced by any such causes. Excluding, therefore, external causes, some internal and individual, or constitutional, tendency must have been in operation. Thus, medullary cancer occurs mostly in persons of apparently scrofulous diathesis, although 89 per cent. seem to have good general health at the commencement of the disease; and in scirrhus, at its first appearance, this proportion rises to 95 per cent. (Paget.)

On the other hand, there are reasons for believing that cancer, like syphilis, is primarily *local*, and only secondarily constitutional. Velpeau is, perhaps, the leading authority who supports this position; and the reasons adduced are thus stated by Mr. Erichsen in his work on Surgery:—

(1.) Cancerous tumours spring up in individuals who have always enjoyed perfect health, and who, to all appearances, are perfectly well at the time of the occurrence of the disease.

(2.) These tumours are not unfrequently the result of some local injury or irritation.

(3.) The constitutional health does not, in the majority of cases, appear to suffer until some months have elapsed; when, as the lymphatics or glands become implicated, or neighbouring tissues invaded, signs of cachexy set in.

(4.) If the disease be removed before neighbouring parts have become contaminated, the health, if it have suffered, often improves materially.

(5.) The patient remains free from any recurrence of the disease for a considerable period, in the great majority of cases.

(6.) In some instances, no recurrence whatever takes place, the disease being eradicated from the system, which could not be the case if it were constitutional.

(7.) Recurrence having taken place soon after an operation, it is almost invariably either in the cicatrix or in its immediate neighbourhood; owing to cancer-cells which had been widely infiltrated escaping removal, and subsequently developing into a new tumour. Were the disease constitutional, recurrence would be as likely to take place in other parts, or in internal organs, as it does when the operation has been too long delayed.

(8.) The same tendency to recurrence after removal, and even to secondary deposit in distant organs, is observed in respect to other tumours which are incontestably, primarily local—*e.g.*, the fibro-plastic and the enchondromatous, and which only become constitutional in their more advanced stages, and in a secondary manner.

This last proposition seems to me fallacious; both the tumours

adduced being "localized" growths, although the fibro-plastic or myeloid variety of enchondroma is undoubtedly a recurring tumour.

External causes.—*Injury* or irritation, is not found to have more than a limited influence on the production of cancer. Thus, scirrhus of the breast seems to have some such origin in less than one case in six; medullary cancer, however, twice as often—one in three cases; colloid is doubtful in this respect; but epithelial cancer has a traumatic origin most frequently—one in two cases. (Paget.) The causative influence of injury is evinced when cancer-growth is the immediate consequence. Instances of this kind are more often met with in the history of medullary cancer. Or again, a broken tooth scratching the tongue or cheek, may induce epithelial cancer in either of these parts; the friction of a clay-pipe, constantly used, may affect the lip in like manner; and the irritation of soot in contact with the scrotum or prepuce appears to induce the well-known chimney-sweeper's cancer of those portions of integuments.

Effects of Cancer.—(*a.*) *Locally.*—*Pain* may be regarded as an effect, produced, apparently, by compression of the nerves in, and around, the cancer-growth; by separation of their fasciculi and fibrils with interstitial deposit; and, in the case of scirrhus, by dragging of the nerves as the growth contracts. Pain is, therefore, due rather to a *mechanical* operation of the tumour, than arising from any vital endowment of the growth itself, which is in fact comparatively destitute of nerves. *Encephaloid* cancer, in particular, is of this character; the tumour scarcely seeming to be sensitive, when cut into during a surgical operation for its removal. *Scirrhus*, however, seems more especially to give rise to pain from *within* itself, the pain radiating thence along the nerves.

The kind and degree of pain vary considerably. Lancinating pangs, particularly when the tumour is handled, are commonly experienced in scirrhus. A hot dart, molten lead, and other such expressions are also used to denote both the character and severity of the pain in this species of cancer. The pain of encephaloid is generally less severe; and colloid is comparatively painless. In cases taken indiscriminately the pain differs; a dull aching sensation, a feeling of weight and coldness, distressing itching, represent these varieties.

The pain varies also in point of date, duration, and constancy. Thus it is not generally of early occurrence: being absent in most cases of scirrhous breast, for the first year or year and a half. Its duration is temporary; occurring from time to time, as when the breast is handled. And cancer, not uncommonly, runs through its whole career without any pain. It is absent in about one-fifth of the cases, including all organs and localities. (Walshe.) The pain is usually proportionate to the rapidity of growth; becoming more severe and persistent when the tumour is inflamed or ulcerating or about to slough, and acquiring the hot burning or scalding character.

The *Lymphatic vessels*, and *glands*, proceeding from the seat of cancer-growth become implicated at an earlier or later period, and in various degrees, according to the species of cancer. Scirrhus, especially, is thus infective, as shown by the axillary glands when the breast is the seat of disease; Encephaloid has the same influence in a lesser degree; Colloid, more slowly, and in the least degree; but Epithelial cancer is very constantly infective, in about the proportion of one in

two cases, although the glands are not involved to so great a distance from the seat of disease, as in the other species of cancer. The results of Paget's observations, respecting the decidedly infective character of epithelial cancer, are at variance with those of Lebert and Haunover.

Cancerous lymphatic glands present more or less enlargement and induration, without any adhesion, or discolouration of the skin, at first. But the course of their disease is similar to that of the primary cancer-growth.

Derangements of function are produced, some of which are *irritative;* as pleurisy and hydrothorax by mammary cancer, peritonitis by ovarian cancer, vaginal discharge by non-ulcerated scirrhus of the uterus. Other derangements are *mechanical;* as effusions by the compression and obstructions of blood-vessels, spontaneous fracture with cancer of bone, stricture of the urethra or bowel, pressure on the brain, spinal cord, or nerves, inducing paralysis, partial or complete, pressure on the optic nerve or from within the eyeball, impairing or destroying vision.

(*b.*) *Constitutional* effects.—The functions of the various parts of the body, other than of the part affected, may continue uninterruptedly for a longer or shorter period as cancer advances. Thus then the general health remains unimpaired, independently of the local disease. Conversely, the *growth* of cancer is inversely proportionate to the general health; being temporarily arrested, if it remain unaffected or is maintained, and coming into activity as it declines. Consequently, with advancing age, there is, so far, a greater liability to cancer; and particularly of the uterus, during the decline of generative power. In like manner the functional vigour of any part of the body apparently protects that part against the production and growth of cancer; whereas the decline of such vigour has the opposite tendency. Thus, pregnancy and lactation protect the uterus and breasts, respectively; while the cessation of those functions is favourable to cancer-growth in these organs. The supervention of either of the functions referred to, is, however, sometimes accompanied with a rapid extension of the disease, or the tumour may remain unaffected by these local changes.

Cachexia is the term used to denote all those functional derangements, chiefly of the circulation, nutrition, and innervation, which together represent the constitutional condition. Feverishness, loss of appetite, nausea and vomiting, distressing thirst, imperfect digestion, obstinate constipation or diarrhœa, "*progressive emaciation* with *peculiar yellow sallowness*," muscular weakness, sleeplessness, and melancholy; such are the leading phenomena of this condition. They are somewhat proportionate to the amount and diffusion of cancer-growth in the system, and hence are more pronounced when it appears in different parts successively, as secondary cancer, and as affecting especially the great internal organs, which minister to the nutrition of the body. Cachexia is most marked in scirrhous, or in encephaloid at an early period of the disease, and least in colloid cancer. Much has been urged for and against the reality of cachexia as a constitutional symptom of cancer. I think the truth may be thus expressed; that an individual affected with cancer often presents a pallid, or perhaps yellowish and emaciated appearance, but that this state is not peculiar to cancer disease. The patient may look very ill and worn, just as in any other chronic disease; and that no such state can be recognized as the *cancerous* cachexia. This acknowledgment, however, amounts only to the fact, that in

regard to cancer, as of nearly all diseases, no one symptom is pathognomonic, but that the diagnosis must be determined by the concurrence of symptoms,—co-existing or successional.

Co-existing Diseases.—Diseases of various kinds may co-exist with cancer, without apparently influencing it, or being influenced by it. Thus, Bright's disease of the kidney has no effect on the course of cancer, which may proceed favourably, even to withering and complete cicatrization, independently. Extensive skin disease, syphilis, caries of the spine, fatty and cirrhosed liver, may severally co-exist. "But," observes Mr. Moore, "exanthematous fevers are unknown in the cancer wards of the Middlesex Hospital, excepting erysipelas, which is not less common in such patients than in others. Erysipelas sweeping over a cancerous ulcer will sometimes efface its specific characters, rendering it a healthy, granulating, and cicatrizing sore. In a few days, or weeks at most, the original kind of ulcer has reappeared. Hospital gangrene, occasionally, has a similar temporary effect, and ultimately the same result. Apoplexy and heart-disease seem to have some protective influence against the production of cancer. Tubercle appears to be no less manifestly incompatible with cancer, while yet related to it." Traces of old tuberculous disease are remarkably common in the bodies of persons dying with cancer, and in 34 per cent. of them phthisis exists in the family; yet the two diseases are never found in active growth together in the same person. Active tubercle co-existing, supplants as it were cancer, which may wither and even cicatrize as the patient is rapidly dying of phthisis.

COURSE.—In the vital history of cancer, certain aspects of its progress are particularly worthy of observation.

Rate of Growth.—Encephaloid cancer takes the lead, growing generally to some dimensions in a short time, or even with vast rapidity. Scirrhus grows more slowly; colloid, with a medium degree of rapidity.

Duration of Growth.—Scirrhus is of longest mean duration, averaging three or four years; encephaloid is of shorter mean duration, averaging about two years; colloid holds a middle place also in this respect. But the *suspension* of cancer-growth for a time, the tumour remaining stationary, is not uncommon. This period may extend even to years. Thus, scirrhous cancer has been known to remain quiescent for ten and twelve years; medullary cancer, in like manner, and perhaps more frequently, for a period of twelve and fifteen years.

Sex appears to have but little influence on either the rate or duration of growth.

Age seems to have some influence; the progress of cancer, generally, being more rapid in the young, and chronic in old persons.

Arrest and Decay.—These changes consist in a cessation of growing, and a destruction of the proper structural elements of the tumour. Cells and nuclei break up, oil-globules and granules are substituted, by a degenerative transformation. The chief element in a *withering* cancer is fat, contrasting with the general emaciation of the body. Scirrhous cancer-growth is thus arrested, in rare instances.

Softening—which contrasts with the hard withering of cancer—takes place, principally, in encephaloid, itself soft cancer. It is transformed into matter having a creamy or milky appearance, very slightly viscid, and the consistence of soft cheese or thin pus. The proportion of milky

opaque fluid, yielded on gentle pressure, indicates the progress towards this change. As affecting colloid cancer, softening represents, not perhaps any further change in its already jelly-like matter, but the breaking down of its containing stroma, with rupture of the loculi and escape of their contents.

The commencement of softening, in any species of cancer, is either at the circumference or centre of the tumour; and in a single spot, or in several spots, simultaneously.

Age seems to have no definite relation to these changes. In old persons, the arrest of cancer is not an uncommon event. One such case, under the care of Mr. Cooke in the Cancer Hospital, was that of a healthy-looking woman, with a ruddy complexion, and aged eighty-two. Scirrhus of four years' duration existed in her left breast, and she had been an out-patient just twelve months. Another instance, in the University College Hospital, was that of a woman aged seventy-seven. The disease had existed for seven or eight years, but was progressive during the last eight or nine months.

TERMINATIONS.—(*a.*) *Resolution and Absorption* is one mode of *spontaneous cure.* This would appear to be synonymous with *Atrophy*,—as the result of withering and induration of the cancer, coincident with fatty, and perhaps calcareous degeneration of its structure, until the tumour has partly or entirely disappeared. Both the ordinary species of cancer-growth have been known to undergo spontaneous cure in this way. But such instances are very rare, and exceptional. Thus, scirrhus of the breast disappeared in a lady whose other breast had been extirpated for this disease. In this case, scirrhus was found in several of the abdominal viscera; the patient having died of asthma not long after the subsidence of the breast-cancer. An encephaloid cancer of the eye of an infant ultimately disappeared, and was followed by dropsy and atrophy of the eyeball. (*b.*) *Suppuration* is another mode of spontaneous cure. A man had a large scirrhous tumour removed from his back. The disease returned. No operation was again performed; but subsequently violent inflammation supervened, an abscess followed with profuse suppurative discharge, and then recovery. (*c.*) *Mortification* may extirpate a cancer, though rarely. The whole tumour is eliminated by sloughing in a mass. None of these modes of spontaneous cure, however, have proved of *permanent* duration.

Cancerous Ulceration and Ulcer.—The former consists in the molecular disintegration or destruction of the structural elements of the textures, as in ordinary ulceration, preceded, however, by interstitial infiltration circumferentially; thus differing from ordinary ulceration. And the infiltrating cancer-elements, although themselves dying, seem to exercise a destructive influence over the proper textural elements.

Species of Cancer, in relation to Ulceration.—Cancer-growth manifests a tendency to ulceration, in different degrees, according to the particular species. *Scirrhus* is inherently disposed to undergo this change, and which is exhibited in either of two ways: by softening and disintegration of the cancer-substance, leading to discharge through ulcerative destruction of the integument; or, by cancerous infiltration with adhesion of the integument to the tumour, resulting in ulceration. Two modes of ulceration, therefore, may be recognized,—the deep or excavating, and the superficial or erosive; the former presenting an ulcer which has characteristic appearances—those of the scirrhous

ulcer; the latter, an ulcer, having no specific characters. *Medullary* cancer evinces less tendency in its substance to ulceration, and comparatively little disposition to infiltration of the integument; but the tumour growing more rapidly than scirrhus, the skin, subject to the mechanical influence of mere bulk, yields partly by tension and attenuation, and partly by common inflammatory ulceration, or perhaps sloughing, the aperture thus formed having the characters of an ordinary ulcer indisposed to heal. The growth protrudes as a fungoid mass, which is liable to repeated attacks of inflammation, with suppuration, ulceration, or sloughing. Hæmorrhage also occurs, from time to time, or interstitial extravasations of blood into the cancerous mass. Consequently, a protruded encephaloid cancer appears in the form of a softened and bleeding exuberant growth—fungus hæmatodes. Diminished in bulk occasionally by ulceration or sloughing, further protrusion takes place, so as to overlay and become adherent to the margin of the ulcer, which then appears everted. *Colloid* cancer is indisposed to ulcerate, although freely infiltrating the surrounding textures. *Epithelial* cancer is very prone to ulceration, as will be described in connection with this species.

The *ulcer* resulting from the process of infiltration, and destruction of texture, presents certain appearances which are most characteristic in the scirrhous ulcer. Of variable size and shape, the edges, at first perhaps thin, irregular, and level with the surrounding surface, or sunken, undermined, and inverted, become thickened, elevated, and everted—a condition commonly observed. The bordering skin acquires a bluish red, or brown tint; and the surface, excavated and irregular, presents large prominent granulations, or a base of slough and blood. A thin, greenish, fœtid, and acrid discharge—ichor—oozes from the ulcer. Other changes may occur which more or less obscure these appearances, but they are chiefly exceptional or accidental. Hæmorrhage, for example, may be profuse, and particularly from the ulcer of encephaloid cancer. The capillary vessels are the usual source of this hæmorrhage; but it sometimes proceeds from erosion of the larger vessels, or from rupture of the varicose veins communicating with the ulcer. An admixture of melanotic matter may occur, as seen also in ulcer of encephaloid cancer. Then again, a cancerous ulcer is liable to those pathological processes which affect an ordinary ulcer; as inflammation and phagedæna.

A cancerous ulcer enlarges slowly or rapidly, both circumferentially and in depth, the whole area of the textures being infiltrated with cancer-elements. Consolidation increasing, the ulcer becomes firm and fixed, both in its margins and base; scirrhous ulcer especially acquires these characters, like this species of cancer in the course of its growth. Hardness and immobility, therefore, superadded to the appearances of margin and surface already described, render the cancerous ulcer more peculiar.

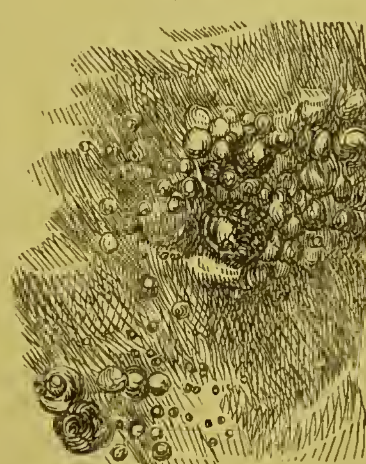
Cicatrization and Cicatrix.—Paradoxical as it would seem that any process of healing should take place in a cancerous ulcer—itself inherently destructive and texturally indisposed to heal—nevertheless, cicatrization supervenes occasionally. Unlike that of an ordinary ulcer, this cicatrization rises over the prominent granulations and dips into the hollows of the ulcer. In the majority of cases, the process and its result are only temporary; as when erysipelas sweeping over a

cancerous ulcer renders it a healthy cicatrizing sore, for a time. But, in some cases, the healing is established, and a sound cicatrix has formed. This has occurred in the ulcers of both scirrhous and encephaloid cancers. Of such unusual permanency, a case is related by Nicod, and several others were observed by Bayle.

The *Cicatrix* of a cancerous ulcer is, in some respects, peculiar. It is extremely thin, of a red or violet colour, and often traversed by large vessels. Contraction is restrained by the firmly adherent skin around, the cicatrix is thus rendered very tense and even more attenuated, and disposed to ulcerate again.

Recurrence of Cancer, locally.—This is a very common event in the vital history of cancer, whether after its separation spontaneously, or removal artificially by the knife. The *period* of recurrence is generally early; in scirrhous cancer, under six months in the great majority of cases (Lebert); in encephaloid, about seven months as the average (Paget); in colloid, a period of uncertain duration; and in epithelial cancer, the period of immunity may extend to months or years. As a general rule, the rapidity of recurrence is proportionate, not to the previous duration, but to the rate of grôwth, of the primary cancer. Local reproduction takes place under different circumstances, which are classed, by Dr. Walshe, as follows:—(*a.*) The process of cicatrization may not distinctly commence, or be interrupted at an early stage, and fungating growths spring from some part of the ulcer or wound. (*b.*) A perfect cicatrix forms, and after a variable lapse of time, a tumour grows in the subjacent tissues, presses outwards the newly formed scar, destroys it, and appears externally with the characters of cancer. (*c.*) In the cicatrix itself, reproduction may occur, by the development of tuberiform cancerous growths. (Fig. 59.) (*d.*) The lymphatic glands, near to the original cancer-growth, may become the seat of recurrent cancer; as often witnessed after the removal of scirrhus, which primarily affected the breast. Encephaloid is said to be the species of cancer usually reproduced, whatever was the original growth; but the accuracy of this observation is doubtful, at least in regard to scirrhous cancer of the breast, the recurrent form of which is equally scirrhus. Colloid perhaps never forms consecutively to either of the other species of cancer-growth.

Fig. 59.*



Recurrent cancer is said to grow more rapidly than the primary cancer, but certainly this is not the rule in regard to scirrhus. Less pain and exhaustion attend the recurrent disease, whether scirrhus or encephaloid, than the primary growth.

Dissemination of Cancer in the System.—Secondary Cancer.—(*a.*) In textures *continuous* with that, or those, of the original growth. Continuity of tissue is here the medium of communication, directly permitting of infiltration. The textures which convey the cancer-elements,

* Returning scirrhus in the breast, after operation; presenting a series of nodules in and around the cicatrix. One in the centre has ulcerated. (Cruveilhier.)

may be naturally continuous, or connected by adhesions. Of the former, Mr. Moore saw an instance where the only cancer in a lung was a small portion of an out-growing cancerous gland of the posterior mediastinum, and the only infected absorbent in the root of that lung was one of considerable size, not more than an inch from the implanted cancer. (*b.*) In *contiguous* textures also cancer may, apparently, spread, without any direct medium of infiltration. Dr. Hodgkin and other pathologists mention cases in which an ovary, the mesentéry, or the liver, being the seats of cancer, the parts in contact with those organs, as the intestine, the walls of the abdomen, the supra-renal capsule or kidney itself, became similarly diseased. (*c.*) In textures and organs *remote* from the original growth, secondary cancer may appear.—(*a*) The *lymphatic* vessels are undoubtedly one channel of transmission. The almost unexceptional infection of the lymphatic glands in the neighbourhood of a cancerous growth,—and which is, indeed, one of the generically distinctive characters of cancers, as a growth—supports this view. Such infection, in relation to primary cancer, is parallel to bubo, in relation to chancre. Either, however, may also be regarded as part only of the primary disease. But cancer can be traced further in the lymphatic system, progressively infecting glands more and more remote from, yet still directly connected with, the part in which the growth first appeared. Surely this diffusion of cancer is secondary. In only about one out of every forty-three cases of fatal cancer is there secondary deposit in internal organs, without infection of the interven-ing lymphatic glands, *en route*, connected with the site of the external primary disease. (β) The *veins*, and venous circulation, would appear to be far less a medium of transmission. Cancer-elements having entered the venous system, through the thoracic duct, the lung, as the proximate organ, would next become the seat of cancer-deposit. Yet, in 173 cases of cancer, the lymphatic glands were infected in 140, the lungs in 22 only. The fact, however, of both these organs being affected, in most cases, and simultaneously, indicates the agency of the pulmonary venous system. (γ) The *arteries* and arterial circulation are engaged even less than the venous circulation. Arterial blood flows to all parts, yet they are not equally prone to cancer. The liver is first in order, thus contrasting with the lungs, among internal organs. It was the seat of secondary cancer in 60 of 173 instances taken indiscriminately, and in 60 of only 90 cases in which the disease spread at all beyond the lymphatic glands of the part first affected The kidney is far less liable,—it was attacked with consecutive cancer twice only in 173 cases; and the spleen but once in that number. The bones and serous membranes are both commonly invaded. These differences of liability suffice to show the extreme irregularity of secondary cancer, in its presumed relation to the arterial circulation, as the medium of transmitting cancer-elements from the primary growth.

One general law respecting the dissemination of cancer in the system, would seem to be this;—it is regulated, in some measure, by the retention of cancerous matter within the body, or its discharge externally through the integuments by ulceration or through some natural passage. Cancer of the uterus with free discharge per vaginam, is followed by secondary cancer in not more than 25 per cent.; whereas deep-seated cancer of the breast produces secondary

cancer in 79 per cent. In calling attention to this important general fact, Mr. Moore justly adds, there are covered cancers, though very few, which remain solitary to the end of life, and there are cancers on free surfaces which do become disseminated.

The successive dissemination of cancer in the system, or primary and secondary cancer, must not be confounded with the *simultaneous* dissemination of cancer, or the production of more growths than one, in different parts, at the same time. The total absence, probably, of functional symptoms at an early period is apt to mislead, *e.g.*, in cancer of the brain, lungs, liver, and stomach, organs of leading functional importance. Thus cancers which are apparently successive may really be simultaneous.

The *relative tendency* of the three species of cancer to affect the system secondarily, differs with respect to each. Encephaloid and scirrhus seem to dispute the first place in this aspect of their vital history. But colloid undoubtedly has here the lowest rank, as also in the other characters of malignancy.

Species and *shape* of secondary cancer.—Encephaloid is produced in the majority of cases; Scirrhus far less frequently, and even rarely, although perhaps always secondary to scirrhus cancer of the breast (Paget); Colloid has not yet been found, in any case recorded. (Walshe.)

The nodular form is that which secondary cancer usually assumes, especially in the liver, lungs, and bones. In a cicatrix, as after excision of a cancerous breast, this form of secondary cancer is very common. Nodules or button-like tubercles appear, which spread and coalesce; or a hard ridge forms in the line of cicatrix. In either case the colour, whitish at first, deepens into a purplish-red hue.

In proximate lymphatic glands, secondary cancer produces—and probably at an early period—tenderness, enlargement, and induration, increasing even to bullety hardness.

Termination by Death.—This, the natural and most frequent issue of cancer, takes place in various ways, which may be concurrent or successive. (*a.*) By the *constitutional* influence of the disease on nutrition and blood-production, as manifested by cachèxia; the proper cancerous death. (*b.*) The direct influence of the disease, *locally*, on various functions, *e.g.*, of the liver, stomach, œsophagus, intestines. (*c.*) Hæmorrhage, internally or externally, *e.g.*, Cancer of the uterus. (*d.*) Exhaustion from pain and discharge, *e.g.*, Cancer of the uterus. (*e.*) Mortification, *e.g.*, cancer of the limbs. (*f.*) Intercurrent diseases, generally of the inflammatory class, *e.g.*, pleurisy, or pnemonia, by cancer affecting the ribs and lungs. (*g.*) Substitute diseases, *e.g.*, phthisis supplanting cancer; tubercular deposit in the lungs, for example, being pathologically equivalent to the cessation of cancer-growth in some other part of the body.

Treatment.—Naturally incurable and fatal as cancer is generally, it may, as we have seen, undergo certain structural changes of a self-curative character, the purpose of which it should be the aim of therapeutics—medical and operative—to imitate. To establish this correspondence between the treatment of injuries and diseases and the processes of Pathology, in respect to their natural courses and tendencies, is one of the leading features of modern Surgery; and this relation of art to the indications of nature, is better illustrated

by the treatment of Cancer than by that of any other Morbid Growth.

(1.) *Arrest of Cancer, and Hygienic and Medicinal Treatment.*—The natural arrest and decay of cancer consists in the cessation of growth, and the disintegrative destruction, of its proper structural elements; changes which are accompanied with, and denoted by, *withering* of the Tumour. This course and termination are observed mostly in the career of scirrhus, as witnessed best in the puckered-up chronic mammary cancer and shrivelled breast of old women. No known medicinal treatment seems to insure this result; although iron, bark, cod-liver oil, the anodyne influence of opium, and such other agents as, apparently, improve nutrition, may prove auxiliary. But hygienic measures, especially in the shape of a generally nutritious and easily assimilated diet, and a cheerful, hopeful tone of mind, will be most efficacious. The growth of a cancer-tumour is inversely proportionate to the arrestive influence of the general health. Thus, when the body is well nourished, the tumour starves.

Local applications are advantageous resources occasionally. Any temporary supervention of inflammation may be treated accordingly, by a few leeches or a light poultice. Pain recurring or persistent, and affecting the general health, is often mitigated by a belladonna plaster, or by conium or opium ointment. A scruple of the iodide of lead in a drachm of glycerine, mixed with an ounce of unguentum opii, is recommended by Mr. Moore. Gently rubbed over the tumour two or three times a day, it reduces any swelling, as well as relieves pain. Soap plaster, used simply to protect, not to compress, the integument, is also calculated to retard the progress of the growth.

Compression may control pain, but its efficacy in repressing growth is doubtful. First tried at the Middlesex Hospital many years since, it was unfavourably reported on by Sir Charles Bell; subsequently, highly extolled by Recamier—who stated that 30 per cent. of his cases were cured—and advocated by Dr. Walshe—it has, nevertheless, not found much favour in this country. Compression is best effected by means of the air-cushion and spring, devised by Dr. Neil Arnott. Pressure varying in force from two and a half to twelve or sixteen pounds can thus be brought to bear on the tumour.

(2.) *Sloughing and Enucleation.*—(*a.*) *By Cauterization.*—This method of treatment is warrantable only in cancer which is already *ulcerated*, and has acquired adhesions beyond the fair reach of the knife.

Cancerous glands, as an extension of the disease, are not so conveniently removed by the application of caustic. But they, and the textures around the slough, mostly become notably diminished in size; an important fact with reference to the glands, compared with their progressive enlargement after removal of the primary tumour by excision. Velpeau's observations seem to confirm this difference in favour of treatment by caustic. It may be followed by successful results, but of temporary duration; a few weeks only—if the disease be incompletely extirpated, or lasting until after the wound has healed—if a healthy granulating surface was obtained. Eventually, in either case, cancer reappears, *in situ*, and runs its course with rarely an exception to a fatal termination.

As compared with removal by the knife, the advantages of cauterization are—the bloodless character of the operation and, consequently,

less exhaustion, and the less liability to erysipelas or pyæmia; the disadvantage is, the pain, severe and persistent.

Various caustics have been employed; the concentrated mineral acids, sulphuric or nitric, or the solid caustic alkalies,—potash or lime, and various chlorides, that of zinc especially. Of all these, the glacial sulphuric acid mixed with powdered saffron, forming a black paste, is preferred by Velpeau, particularly in fungoid and bleeding cancers. The caustic alkalies combined, form the well-known Vienna paste. The chloride of zinc mixed with flour readily forms a paste by deliquescence. If a liquid caustic be used, the surrounding skin should be protected by a barrier of gutta-percha or other similar material attached to the skin. If chloride of zinc be used, the skin, which resists this agent, must previously be destroyed by sulphuric or nitric acid.

The depth to which the action of any such agent extends and the destruction of the tissues accordingly, will depend on the strength and quantity of the caustic employed. But the result can only be roughly estimated. The slough produced varies in appearance with the kind of caustic employed ; a dry, hard, contracted blackish eschar, resulting from the application of a strong mineral acid; a wet, pulpy slough, from chloride of zinc. It separates after a time, a few days to a month, disclosing a healthy granulating surface, but perchance, of prodigious depth and extent. Other modes of applying caustics have, therefore, been devised. The *repeated* introduction of chloride of zinc through incisions daily made deeper and deeper, affords a precaution for limiting the slough to the depth and extent of the cancer. This plan of treatment was first practised in this country by Dr. Fell, of the United States; a report on which was drawn up by the Medical Staff of the Middlesex Hospital, in 1857. Another mode is to undermine a cancer with caustic, introduced through narrow passages pierced with a seton needle.

Of all these caustics, my own experience inclines to the chloride of zinc, which I first saw used by Mr. Liston, many years ago, and the efficacy of which has since been attested by its results in some cases.

In the ulcerated stage of cancer, disinfectants become requisite, for the double purpose of cleansing the sore, and of counteracting the effects of that peculiar fœtor which would otherwise encompass the patient in a self-created poisonous atmosphere. Charcoal or yeast poultices, and lotions of chloride of lime or carbolic acid, are thus beneficial. I can speak favourably of the latter poultice and lotion. They were remarkably efficacious in the case of a large cancer springing from the arm and involving the shoulder. Ulceration having commenced in front of the axilla and subsequently in other parts of the tumour, the odour would have been intolerable to the patient but for these appliances.

(*b.*) *Congelation.*—The continued application of intense cold, is another means of destroying a cancer. Used in conjunction with caustic, congelation mitigates the pain, without diminishing the cauterization. Freezing is, alone, far less effectual. When most successfully practised, its destructive action extends not deeper than an inch; the only advantage then being the freedom from pain during and even after this process. As a method of treatment for cancer, it was introduced by Dr. James Arnott. Pounded ice may prove sufficient; but a mixture of ice, salt, nitrate of potash, and hydro-

chlorate of ammonia, will freeze more thoroughly. The frigorific mixture should be circumscribed by gutta-percha or other pliant material, fashioned into a bowl around the part, with a tube to drain off the fluid as the mixture melts; and the process must be continued for some hours.

(3.) *Excision*, or *amputation*, for the *immediate* removal of cancer, is the treatment most worthy of consideration. Granting the local origin of cancer, and thence the subsequent infection of the system; excision—as distinguished from any *process* of removal—is indicated, and at the earliest possible period. Hence also amputation, where practicable, may be preferable to excision—a partial operation, which may not thoroughly extirpate the disease. The delay of either operation will assuredly allow the infiltrating course and adhesions of cancer to ensue, thereby rendering it locally impracticable or constitutionally useless.

These pathological considerations suggest certain general reasons in favour of both excision and amputation, and their comparative advantages.

(i.) Extirpation of the disease, entirely and permanently. This is very rarely accomplished.

(ii.) Temporary removal of the disease, and thence a proportionate restoration of ease and health. This immunity is always gained.

The period of non-recurrence varies; perhaps less than one, it averages two years. Early performance of the operation may prolong this period to ten, fifteen, or twenty years. Such prolongation has been observed particularly in scirrhus affecting the breast. The experience of Velpeau and of Sir B. Brodie concur as to the long period of immunity which may be enjoyed.

(iii.) Prolongation of life. Comparing the duration of life in cases without operation, and after, Sir James Paget states that, in the former case, the average period scarcely exceeds two years; whereas, in the latter, it extends to about twenty-eight months. Mr. Moore goes much further, observing that in seventy-eight cases of cancer affecting the breast, not operated on, the average duration was 32·25 months; and in fifty-seven such cases the average was 53·2 months. Any estimate of this kind is liable to a twofold error; the selection of cases for operation is generally those most favourable to life, and the probable mortality of the operation itself. The latter varies from five to ten per cent.; and albuminuria peculiarly predisposes to a fatal issue.

Objections with regard to each of the three foregoing considerations may be raised as to the propriety of operative interference, but the same objections apply with equal or greater force to any kind of treatment whatever, in the course of a disease so, apparently, irregular as that of a cancer. The *species* of cancer affects the estimate as to the average prolongation of life, with and without operation. Thus, in Scirrhus, the relative periods may be stated as fifty-two months against forty-eight months, or even a still more advantageous difference (see Cancer of Breast); in Encephaloid, thirty-three months against twenty months; in regard to Colloid, the difference is undetermined; but, in Epithelial Cancer, the relative periods are, with operation, fifty-seven months, without operation twenty-seven months, or less than half the duration of existence granted by surgical interference.

The conditions of cancer, or the cases which are respectively favour-

able and unfavourable for operation, may be stated, approximately, as follow; cancer of the breast being taken as the type:—

(*a.*) *Favourable* for operation.—(1.) A single tumour, not diffused, and whether in the nipple, on the surface, or in the substance of the breast. (2.) When the nipple alone, or some very limited portion of the skin, is drawn in towards the subjacent tumour. In either case, the integument not being widely infected but simply dimpled, the breast may be removed. But the disease is apt to return in and around the cicatrix. This took place in the case of a scirrhous breast which I removed in the condition described, a small portion of skin not larger than half a crown being attached to the gland. (3.) Ulceration of a cancerous tumour does not preclude operation, if in other respects the case is suitable. (4.) The glands having become diseased to an extent which does not interfere with their removal, is a condition proportionately favourable for excision of the primary tumour. But the state of the glands cannot be exactly determined, otherwise than in the course of the operation, and if then found to be cancerous, they also must be removed; not necessarily, however, at that time, if such an enlargement of the operation might be perilous. Subsequently, and as soon as the health permits, the cancerous glands should be excised. This postponement I had recourse to in the case of a lady whose breast I removed for cancer; when the wound had healed, I *then* removed the axillary glands—by a more limited incision than a continuation of the original operation would have involved. The disease eventually returned in the breast-cicatrix. (5.) Amputation of a limb is justifiable, although the glands show some hardening or doubtful enlargement. This rule applies both to the encephaloid and epithelial disease. (6.) Hereditary tendency, strongly manifested, does not entirely prohibit operation. In a family, of which six members were the subjects of cancer, one sister underwent excision of the breast in 1845, and another in 1846. Both remained well, until in each, with a recent recurrence of the disease, a second operation was performed in 1856 — eleven and ten years after the primary operation. In 1859 both patients were alive. (7.) Recurrent cancer may be removed under the same restrictions, as with reference to a first operation. My own experience of operation in such cases, is not favourable. In two—the original disease having been mammary scirrhus—one or two only small button-like nodules reappeared in the cicatrix; these were at once excised, yet the disease speedily returned again. (8.) Age does not prohibit the removal of a growing cancer.

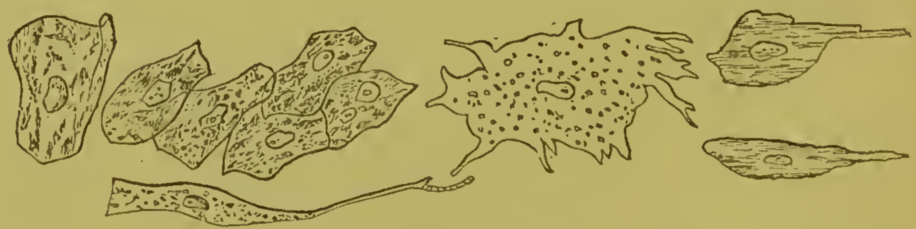
(*b.*) *Unfavourable* for operation.—(1.) Certain constitutional conditions—*e.g.*, cancer co-existing, especially in some internal organ, or marked cancerous cachexia, albuminuria or other grave organic disease. (2.) Diffused cancer and persistent œdema. But the latter condition is significant only when circumferential; œdema remote, depending on obstruction to the circulation at the seat of disease, *e.g.*, œdema of the hand from cancer of the arm, is not itself a prohibitive condition. In such case, I have seen the swelling subside and return; apparently with varying states of the circulation as connected with the growth of the cancer above. (3.) Adhesion, if at all extensive, either of the skin, or subjacent textures, is decidedly prohibitive of operation. (4.) Ulceration, otherwise than to a very limited extent and depth, is equally so. (5.) Cancerous tubercles in the skin over a cancer, is a condition even more unfavourable for operation. Over a mammary cancer, increasing

thickness of the skin, its widespread adhesion, and enlargement of the pores, constitute a decisive contra-indication. (6.) The glands having become diseased to an extent which interferes with their removal, prohibits also removal of the primary tumour, either by excision or amputation. (7.) Rapid growth, in any way, is decidedly unfavourable for operation. Hence most encephaloid cancers are better left alone, unless in a very early stage. (8.) Cancers, the relations of which to important parts around cannot be foreseen, are better not meddled with. Thus circumstanced, are cancers beneath the scalp, which often implicating the bone, penetrate the skull; cancer of the eye, which often involves the optic nerve; cancer of either jaw, particularly the upper, where it is apt to protrude into the maxillary sinus or the ethmoid cells; and cancers about the root of the neck. I once assisted my colleague Mr. de Méric in removing an encephaloid cancer situated about the sixth rib, below the fold of the pectoral muscle on the right side. The tumour was not larger than an orange, the skin unbroken, and it seemed movable on the rib. Yet, on commencing the operation, the hæmorrhage was alarming, the rib gave way, and any further attempt was at once discontinued. The man, of florid complexion, became blanched with almost fatal syncope in a moment, and rallying only for a short time, he died of internal hæmorrhage; a warning in all such, and similar cases.

Epithelial Cancer.—One *variety* of cancer I have reserved for special description; because, although in many points allied to encephaloid and somewhat to scirrhous cancer, it nevertheless presents very characteristic appearances, and possesses much surgical interest. I allude to epithelial cancer.

Structural Condition and Diagnostic Characters.—This variety consists essentially of cells or scales, resembling those of scaly epithelium, infiltrated among the component elements of the skin or mucous membrane, or sometimes among the textures of internal organs. Whatever portion of the skin or mucous membrane may be thus affected, the epithelial cancer-cell or scale has very much the same characters. (Fig. 60.) It is flattened, of an irregular outline, with usually a pro-

Fig. 60.*



longed diverticulum at some point of its margin, and of a variable size. It contains pale molecular matter, converging towards a central nucleus, which is clear, bright, and well-defined, round or oval, and very small in comparison with the cell; more uniform also in its shape and size. This nucleus is usually single. It may contain two or more minute granules, but rarely a bright distinct nucleolus.

Associated with these cells, are what Paget calls "brood-cells," or

* Epithelial cancer-cells or scales in various forms. Magnified 350 times. (Paget.)

endogenous cells. They present many varieties of appearance, which may be regarded as the results of one or more nuclei, enclosed within cells, assuming, or tending to assume, the characters of nucleated cells.

The "globes epidermiques" of Lebert (Fig. 61)—"laminated capsules," Paget—are the most singular and characteristic structures of epithelial cancer, yet not peculiar to this disease; nor are they, apparently, special structures, for they consist of epithelial scales. These capsules are very large and spherical cysts, containing granular matter, nuclei, or cells, obscurely seen within them; and clustered so as to almost appear as if fused together; but each capsule consists of epithelial scales, superimposed in successive layers, thus forming a laminated capsule.

FIG. 61.*

Such are the structural elements of epithelial cancer. They are found infiltrated—principally in the substance of the skin or mucous membrane—but not uniformly diffused throughout the component textures of the part affected.

The cancer-cells may predominate in the corium, forming a swelling very slightly elevated above, or imbedded below, the proper level of the integument, and the depth or thickness of which is much less than its dimensions laterally; or these cells may predominate in the papillæ, presenting a prominent warty or exuberant out-growth; or, the sub-integumental texture may be their chief seat, forming a deeper-seated, flat, or rounded mass.

Of these varieties, the first two may be named the *superficial* or out-growing; while the third is the *deep-seated* form of epithelial cancer. Paget believes that either of these principal varieties may occur in any of the usual seats of this disease, but that they are not both equally common in every such part. The superficial, and especially those which have the characters of warty and cauliflower-like out-growths, are most frequently found on mucous membranes, especially of the genital organs; those also on the extremities and the scrotum have usually a well-marked warty character, and are rarely sub-integumental. The deep-seated are more frequent in the tongue than elsewhere.

It must not be forgotten, however, that these distinctions are more *apparent* than essential. Their value consists in reference to the earliest and most exact diagnosis of this disease, in whichever form it may chance to make its first appearance. For subsequently, and especially when ulceration has commenced, an epithelial cancer which was superficial or exuberant, is prone to extend into deep-seated parts; and one at first deeply seated may grow out exuberantly. Moreover, when ulceration is progressing, a greater uniformity of external appearance is found; because, in general, while all that was superficial or exuberant is being destroyed, the base of the cancer is constantly extending, both widely and deeply, into the sub-integumental tissues.

* Object to the left, a single globe epidermique. (Lebert.) Object to the right, formation of a laminated epithelial capsule, by endogenous development of nuclei into nucleated cells, their detrusion, and concentric lamination. (Rokitansky.)

Respecting, then, the *earliest* appearances of epithelial cancer, the following are most *diagnostic.*

1. Of the *superficial* or *out-growing*, prior to ulceration, they are these:—

(*a.*) An *outspread* swelling arises—say on the lower lip, labium, pudendi, or scrotum; and an unnatural firmness or hardness of the affected skin is perceptible; but the superficial dimensions much exceed the thickness of this swelling. Its outline is round, oval, or sinuous; and its surface, sometimes nearly smooth, is more often coarsely granulated—like that of a syphilitic condyloma—deriving this appearance from the enlarged and closely clustered papillæ. Generally, the surface is moist with an ichorous discharge; it may, however, be covered with a scab, or encrusted with a soft substance, consisting of

FIG. 62.*

detached epithelial scales. In most cases, the part is unduly sensitive, and injected with blood. If the papillæ become infiltrated, they constitute the *cauliflower*-like mass so characteristic of the ordinary form of epithelial cancer. (Fig. 62.) This mass looks very vascular, is moist with ichor, and covered with pasty cakes of epithelial scales, which beset the interstices of the enlarged papillæ.

(*b.*) Occasionally, the shape of an out-growing epithelial cancer is that of a *sharply bordered circular or oval disc*, upraised a little above the level of the adjoining skin, or mucous membrane, and imbedded to about the same depth below it. The surface of this disc—usually flat or slightly concave—is granular, spongy, or irregularly cleft; and its margins are surrounded with healthy texture, which becomes raised and often slightly everted by their enlargement—*e.g.*, many epithelial cancers of the tongue.

(*c.*) Sometimes, epithelial cancer grows out in the form of a *cone.*

* Epithelial cancer of hand; showing the papillary character, from specimen in the Museum of St. Bartholomew's. (Ser. x. i. 6.) The history of this case is in Pott's Works by Earle, iii. 182. The patient was a gardener, who had been employed in strewing soot for several mornings. The disease was of five years' duration. (Paget.)

(*d.*) Lastly, the out-growing form of this disease may be a *narrow-stemmed*, and possibly pendulous, growth from the skin.

These and other shapes of superficial epithelial cancer resemble somewhat the appearances presented by warty and condylomatous growths; but they differ essentially in respect of their minute structure;—being infiltrations of the skin and papillæ with epithelial cancer-cells; whereas the structure of warty growths remains healthy, however strange may be the appearance they assume.

(2.) *Deep-seated* epithelial cancer is generally (*a*) an *advanced stage* of the superficial; for by progressive infiltration, the subcutaneous or sub-mucous tissues are invaded; (*b*) but this variety of the disease may occur *primarily*, although comparatively rarely. "Thus," observes Paget, "the first formation of epithelial cancer may be in masses of circumscribed infiltration of the tissues, beneath healthy skin or mucous membrane. This condition is more frequent in the epithelial cancers that form, as recurrences of the disease, near the seats of former operations, or as secondary deposits about the borders of primary superficial growths."

Situation.—Epithelial cancer selects either the skin or subcutaneous texture; or the mucous membrane; and of these textures the portions most liable are ranged by Paget in the following scale of frequency. First, its chosen seat is the *lower lip*, at or near the junction of the skin and mucous membrane; then the *prepuce* (glans, Rokitansky), *scrotum* of chimney-sweeps; the nymphæ, the tongue; occasionally in very many parts; as at the anus, interior of the cheek, upper lip, mucous membrane of the palate, larynx (trachea, Rokitansky), pharynx and "cardia;" neck and orifice of the uterus (stomach, Rokitansky), rectum, and urinary bladder; skin of the perineum, of the extemities; the face, head, and various parts of the trunk. In yet more rare instances, as a primary disease, it occurs in other than integumental parts; as in the inguinal lymphatic glands, in bones, in tissues forming the basis or walls of old ulcers. Rokitansky has met with epithelial cancer only once in a parenchyma, namely, in the liver, and then encysted in a capsule of fibro-cellullar tissue. By extension from its original seat, this growth may involve many deeper textures; fasciæ, muscle, bones; and as a *secondary* disease it may, but very rarely, supervene in internal organs—the lungs, liver, heart, spleen, or kidneys.

Epithelial cancer, as a primary disease, is usually *solitary*. Occasionally, two or more co-exist, and even in the same part, as on the prepuce and glans. Eventually, secondary epithelial cancer-growths form in the tissues surrounding the primary and parent growth.

Origin.—Predisposition to the production of epithelial cancer increases as *age* advances, the proportionate liability rising with each decennial period. This becomes more apparent when compared with the number of persons living at each successive period; so that if the frequency of occurrence between 20 and 30 years be represented by 12, that between 40 and 50 years is equal to 100. Billroth estimates the period of greatest liability to be from the fortieth to the sixtieth year, rarely later; but sometimes the disease appears in childhood. With regard to the part affected, Sir J. Paget believes that the mean age of occurrence is lowest in the sexual organs, and highest in the integuments of the head, face, eyelids, and upper extremities. *Males* are more often attacked than females; in 105 cases affecting parts common

to both sexes, 86 were in men, 19 only in women. *Hereditary* predisposition would seem to be traceable in members of the same family; or where scirrhus or encephaloid cancer has affected some, other members have been the subject of the epithelial disease.

External Causes.—Previous injury of the part is more often predisposing in regard to the production of epithelial cancer than of perhaps any other kind of tumour, excepting melanotic cancer of the skin. But the injury is generally some slight and oft-repeated damage, as by frequent blows or friction, thus amounting to prolonged irritation. The habitual smoking of a clay pipe, as affecting the lip, and the irritation arising from soot lodged in the crevices of the scrotum, are familiar examples of the external causes of epithelial cancer. It is often seen to proceed from a crack or fissure, to appear in the form of a small hard knob, lump, or scabbing wart. Some chronic morbid condition of a part may become the seat of the disease; as a cicatrix, especially when exposed to injury.

Course.—Epithelial cancer is constantly progressive, but its rate of progress varies from time to time, and according to the part affected. The disease may run its course in a year, or continue for three, five, ten years, or longer. Sometimes advancing slowly, in a year it gains only the fraction of an inch on the part around; or spreading rapidly, in a few months it invades to the extent of several inches. This progress is perhaps now and then interrupted by partial cicatrization—when ulceration had supervened. But the average rate of progress is less than that of any other species of cancer-growth. And, with reference to the part affected, epithelial cancer advances more slowly in the scrotum and lower limbs; more rapidly, and with great malignancy, in the mouth, tongue, and penis. The deep-seated form of growth is also more malignant than the superficial or out-growing.

The *ulcerative* stage of epithelial cancer is that in which the disease is commonly seen; and the usual state of ulceration observed is that of progressive destruction of the central and superficial parts of the cancer, with more than co-extensive growth of the marginal and deeper parts, thus constituting the type of the "cancerous ulcer."

It is important, therefore, to be able to discern the *first* aspect of ulceration—both as regards the superficial and the deep forms of epithelial cancer, respectively; and then, the characters of the complete ulcer.

(1.) Ulceration of *superficial* or out-growing epithelial cancer, primarily appears as either a diffuse excoriation of the whole surface of the cancer, except its borders; or else a shallow ulcer limited at first to some fissure where the disease commenced. The discharge from this excoriated or ulcerated surface dries into a thin scab, or a thicker and darker crust; which conceals for a while the ravages of ulceration, still slowly extending beneath,—downwards and outwards.

(2.) Ulceration of *deep* epithelial cancer begins in one of three ways:—

In some cases, the superimposed skin or mucous membrane having become adherent and thin, cracks; and this condition may remain stationary for a long while, in the form of a dry dark crevice; but usually ulceration, commencing from this point, extends into the mass of the cancer.

In other cases, the substance of the cancer having become inflamed,

it softens, suppurates, and discharges its contents through an ulcerated opening, or a long rent; leaving a cavity which speedily assumes the characters of an ulcer, and extends peripherally.

In a third series of cases, and, perhaps, especially in secondary formations, and in those under the scars of old injuries, the cancer protrudes through a sharply bounded ulcer in the sound integument or scar, growing exuberantly, with a soft shreddy surface, like a medullary cancer, or with a firmer, warty, or fungous mass of granulations.

Dissimilar as are the earliest aspects of ulceration in both forms of epithelial cancer—out-growing and deep—they gradually assume a uniformity of appearance which is very characteristic.

(3). *Complete Ulcer.*—An excavated sore, of a round or oval shape, presenting a roughly granular surface, which has a brick-dust red colour, and oozes a stale-smelling discharge. This surface bleeds easily, although not freely. The textures surrounding its base and borders become indurated and rigid, as they progressively become more and more infiltrated with cancer-cells. The ulcer thus acquires a remarkable degree of immobility, and its margin protrudes in the shape of a thick everted ridge, well defining the boundary of the ulcer. Infiltration increasing, the marginal ridge forms an irregular nodular belt, which overhangs the base of the ulcer, and gives an undermined appearance to its everted borders. If the *papillæ* of the surrounding skin are more particularly the seat of cancerous infiltration, then a warty rather than a nodular belt springs up around the ulcer. With all these signs of progressive infiltration, followed by ulceration, the work of destruction is not stayed below the *base* of the already excavated sore. It spreads deeper and deeper, sparing no texture, not even large arteries, which hold out against the invasion of most other forms of ulceration, if indeed they do not escape altogether. But arteries of the first magnitude yield to the unsparing ravages of epithelial cancer.

Pain, varying in kind and intensity, such as burning or neuralgic pain, attends the course of ulceration. The lymphatic glands are infected at an early or later period, according to the rapidity of the disease; and involving the proximate glands, which become enlarged and somewhat indurated, the disease extends to other glands, yet not so far as in other species of cancer. Thus, when the lip is the primary seat of disease, the cervical glands are secondarily affected; while the lumbar glands show the extension of disease from the penis or scrotum. Internal organs are far more rarely infected than from any other species of cancer. Cachexia is neither early nor well-marked; nor in any way peculiar. The *average duration of life* is from two years to two and a half; although life is not unfrequently prolonged to three or four years, or to a more distant period,—unlike the usual course of other cancers. Here, also, the part affected will regulate the prognosis. Epithelial cancer in the limbs generally runs its course to a fatal termination more slowly than when the lower lip or the tongue is the primary seat of disease. The age of the patient, at the commencement of the growth, scarcely influences the duration of life.

Affinities to Cancer.—There are good and sufficient reasons for regarding this disease as a *variety* of Cancer. Its infiltrating character as a growth, is the essential guarantee of identity; while its indiscriminate invasion of all textures, its ulcerative tendency, and unsparing destructiveness, corroborate the malignant nature of this growth. Then

again, the lymphatic glands are early liable, although not prone, to become affected by the continued epithelial infiltration of the primary growth; but secondary formations thence arising are almost exclusively limited to glands in connection with the immediate vicinity of the primary disease. A similar epithelial form of growth, or more commonly encephaloid cancer, may however ensue, and indiscriminately in parts distant from the original disease; and there is also the less significant fact of recurrence, sooner or later, after removal by operation. Lastly, in point of hereditary influence, members of the same family, in whom either scirrhous or encephaloid cancer occurs, are peculiarly liable to the epithelial form of growth. Duly weighing all these affinities, singly and collectively, this epithelial growth is rightly denominated epithelial *cancer*. In this conclusion the most able pathologists concur; Rokitansky, Virchow, Paget, and others.

Epithelial cancer must not be confounded with the "Epithelioma" of Hannover and Bennett, who include under that title many other growths besides this variety of cancer; and it differs also from the "cancroid" of Lebert.

Treatment.—The guiding indications of treatment in respect to epithelial cancer are two; one or other of which is always practicable.

(1.) To superinduce inflammation and sloughing, thus destroying the cancer. This may be accomplished by caustics, such as those already mentioned for the destruction of cancer generally; the strong mineral acids, caustic alkalies, and chloride of zinc. But it must be confessed that this method of treatment is not more successful in the one case than the other. In one instance, of an epithelial cancer of the entire circumference and nearly the whole length of the vagina, I repeatedly applied the strong fuming nitric acid by means of a glass brush; but without apparently any effect, for better or worse.

(2.) Removal of the cancer is the most effectual treatment. This may be accomplished by excision, ligature, or amputation.

The former method is, generally, most eligible; care being taken to cut sufficiently wide for the entire extirpation of the growth. It will be necessary to include any neighbouring lymphatic glands which have decidedly become secondarily affected by the cancerous infiltration. But the strong infiltrating tendency of epithelial cancer renders its effectual removal by excision doubtful. Removal by ligature, or the ecraseur, is the alternative method; wherever excision is impracticable, or would be imprudent, or inefficient.

Amputation is necessary, primarily or secondarily, in certain cases. It may be so, in the first instance, owing to the extent of the disease, or its locality, as when situated on the leg, or the arm, near the trunk. Of the latter urgency for amputation I had an instance in the case of an epithelial cancer just below the shoulder-joint. The patient died, after the operation, of Hospital gangrene. Secondary amputation is unavoidable in any case of recurrent cancer; caustics, excision, ligature, or even primary amputation, as the case may be, having failed, perhaps successively, to extirpate the primary disease.

Recurrence of the disease after apparently complete removal by operation is, I believe, the rule, without exception. And the epithelial growth returns sometimes in the cicatrix, sometimes in the lymphatic glands, when previously healthy. The period of recurrence varies considerably; being very early, or much longer after operation,—a

year and a half, possibly to five years, or an indefinite time. But the *prolongation of life* is a very advantageous consideration. The average duration after operation is nearly five years,—thereby granting a period about twice as long as without operation, or an additional two years and a half, as the advantage gained by timely surgical interference.

False Tumours.—Certain swellings, or even distinct lumps, of a transient or movable character, are apt to arise occasionally, simulating morbid growths or tumours properly so-called, in various parts of the body.

Phantom tumours, appearing and disappearing, may arise from partial contraction of the muscles, any such tumour presenting a firm elastic swelling; as in the walls of the abdomen. When the part becomes relaxed, the apparent tumour subsides. Or, it may travel to another portion of the same muscle, by a similar lumpy contraction, as a shifting tumour, and then to other parts, in a succession of such tumours. These muscular lumps occur mostly in females of an hysterical temperament, being, in fact, a local manifestation of the constitutional malady; and their nature will be further declared by the apparent tumour vanishing when kneaded with the fingers; or, if the muscle be relaxed under the influence of chloroform, no further doubt can be entertained. *Floating* tumours not unfrequently form within the abdomen, a lump appearing, or becoming perceptible on careful palpation with the hand; but the lump is freely movable, and easily slips away from the touch to some other part of the abdomen, where it may again be found. The patient also feels these migratory movements. Any such tumour may be firm and elastic, and of the size and shape of a kidney; being met with also on one side or the other, commonly in the right loin, the lump resembles a movable kidney, and this, in some cases, is its real nature. But the tumour may be only a dough-like lump of fæces impacted in the cells of the colon, or a tympanitic and sacculated distension of the intestine—these conditions occurring mostly in hysterical women; and sometimes an ovarian tumour or cyst, loosely attached, may have a floating character, with a more or less solid or fluid consistence.

The *treatment* of any false tumour must of course be guided by its supposed nature. As an hysterical affection, the treatment appropriate might thus prove remedial. But often the phantom or floating lump baffles alike the suggestions of pathology and the resources of experience.

CHAPTER III.

DEGENERATIONS.

To clearly understand the significance of the term degeneration, it is necessary to bear in mind the nature of healthy nutrition, of which physiological process, Degeneration is only another modification,—concluding the Pathology of Nutrition.

The functions of the various organs and parts of the body, in health, are so adapted or adjusted as to constitute an evenly balanced living

organization. And this co-operation is continued throughout life, in health. But the activity of all the functions—nutrition, for example—varies considerably during the successive periods of existence.

After birth and with an independent existence, during infancy, youth, and adolescence to maturity, the function of nutrition is yet more one of *growth* and development. During mature manhood or womanhood, this function is simply one of *maintenance*, to repair the muscular waste of the body consequent on the functional exercise of its various members and organs. Lastly, as age approaches, and during decrepitude, the nutritive power of the body proportionately declines. Waste is still repaired; but the textural structure reproduced is an imperfect representation only, not a copy, of either its original or mature condition; it is a *retrogression* of textural structure, effected by a *degenerative* modification of nutrition. Degeneration is, therefore, only the concluding stage of the natural course of healthy nutrition, and as the retrogression of textural structure extends more or less throughout the body, and certainly pervades vital organs, the whole organism retrogrades or reverts to the unorganized matter whence it came. Earth returns to earth, ashes to ashes, dust to dust. To die by degeneration is, therefore, as natural as to live by growth and development, and by the subsequent maintenance only of nutrition. This function is, indeed, the consummation and resultant of all the other organic functions; and when in the order of nature they decline, nutrition declines also into degeneration, which it then represents. But this ultimate modification of nutrition is sufficient for life as age advances, all other functions declining at the same time, and in due proportion.

The *senile* retrogression of textural structure, thus effected, cannot, in any sense, be designated a diseased condition, nor the result of any morbid process. Nor again, when degeneration, natural to advancing and advanced life, occurs *prematurely*, can it *then* be regarded as a morbid process of nutrition, issuing in a diseased condition of textural structure. It is only premature old age; but the individual overtaken by degeneration is the subject of *defective* nutrition, and in this sense only, retrogression of textural structure by degeneration ranks, and may be classed, with morbid products of Nutrition.

Degeneration, whether senile or premature, is a form of atrophy; but it is so by a deterioration of structural quality, not by a mere diminution of quantity. And, be it observed, this structural deterioration is effected by the relapse or falling back from a higher condition to a lower or more elementary grade of textural structure, or even to an altogether structureless condition. It moreover, takes the place of or substitutes the proper elements of the original texture, which disappear.

This *relapse* and *substitution* of textural structure, are the essential characteristics of Degenerative transformation. By substitution, it is distinguished from the transformation of texture resulting from simply Disintegration.

Causes.—Analogy and facts alike concur to render the conclusion highly probable that degeneration, as being a modification of nutrition, is caused primarily by an appropriate blood-disease, in regard to each kind, of which it is the local and anatomical manifestation.

On the other hand—as Paget observes—degeneration, like simple atrophy of quantity may arise from local causes, and apparently the

same such causes; namely, diminished supply of arterial blood, as by partial closure of the chief nutrient artery of the part; or by abrogation or suspension of function. Futhermore, both degeneration and atrophy occur commonly in old age, but possibly prematurely; both also may occur simultaneously in one and the same texture, under precisely the same conditions; and a cause of atrophy in one case may cause degeneration in another. In relation to disease, both may co-exist, as in inflammation; or the disease, so called, may be only degeneration, as in simple softening of the brain or spinal cord, and the liquefaction of inflammatory exudations during the suppurative process.

General characters of Degeneration.—(1.) The new material is of lower chemical composition; *i.e.*, less remote from inorganic matter, than that of which it takes place. Thus, fat is lower than any nitrogenous organic compound, and gelatine lower than albumen, and earthy matter lower than all these.

(2.) In structure, the degenerate part is less developed than that of which it takes the place: it is either more like inorganic matter, or less advanced beyond the form of the mere granule, or the simplest cell. Thus, the approach to crystalline form in the earthy matter of bones, and the crystals in certain old vegetable cells, are characteristic of degeneration; and so are the granules of pigment and of many granular degenerations; and the globules of oil that may replace muscular fibres or the contents of gland-cells, and the crystals of cholesterine that are often mingled with the fatty and earthy deposits.

(3.) In function, the part has less power in its degenerate than in its natural state.

(4.) In its nutrition, it is the seat of less frequent and less active change; and without capacity of growth, or of development.

General Treatment.—The pathological indications of treatment, in regard to degeneration, are two:—

(1.) To elevate the condition of degeneration to some higher state of textural structure. This indication cannot be fulfilled by any known Hygienic or Therapeutic measures. The practicability of effecting recovery from degeneration would seen to be inconsistent with the vital incapacity of a degenerate part for growth or development.

(2.) To counteract any further degeneration in an already degenerate part, or its extension to texture continuous. This indication may, perhaps, be accomplished by Hygienic and Therapeutic measures, either of which are general or topical. It would appear that whatever influence, of a preventive tendency, any such measures may have, their action is mainly through the medium of the blood, by raising its quality and promoting its circulation.

Hygienic measures, of a counteractive character, have reference to the functions concerned in blood-production. Diet, selected with regard to the particular form of degeneration, pure air, friction of the skin, shampooing, baths warm or cold, regular exercise, and other means of promoting excretion, are thus highly important.

Medicinal measures, within the present range of therapeutics, are less obviously counteractive of degeneration. Iron, cinchona bark, the mineral acids, and other tonics, may have some beneficial influence, by improving the quality of the blood and invigorating the circulation; while aperients, diaphoretics, and diuretics increase and regulate the excretions of the bowels, skin, and kidneys. Some such resources are

found in convenient, and apparently inimitable combinations, in the various natural chalybeate and saline mineral waters of Vichy, Wiesbaden, and other Spas. In such resorts, persons of a "broken or worn-out constitution"—subjects of degenerative changes of structure—experience a temporary revival of their failing powers, if not a permanent restoration to health.

Rarely will any topical applications prove beneficial; degeneration of any kind, and perhaps affecting internal organs, can scarcely be influenced by such treatment.

Special Kinds of Degeneration.—Pathologists differ as to the number and specific distinctions of the various kinds of degeneration. The classification of Paget is not that of Dr. J. Hughes Bennett; nor this, again, that of Dr. C. J. B. Williams.

As this branch of Pathology stands at present, I would propose the following arrangement:—(1) Fatty degeneration; (2) Pigmentary; (3) Fibrous; (4) Amyloid? Waxy, or Lardaceous; (5) Granular; (6) Calcareous, osseous, or mineral degeneration.

These various forms of degeneration are of much pathological interest in Surgery, as well as in Medicine; and it is a subject upon which, respecting Fatty degeneration in particular, I have made a series of microscopic observations, both in animals and the human species.

The Student, to whom it may be necessary that he should enter further into these modes of degenerative transformation, will find the following summary of service, which is revised from my work on "Principles," now out of print. He will thus be enabled to supplement his *pathological* knowledge as relating to the normal tissues, as well as pertaining to the products of Inflammation, and Tumours or Morbid Growths; the whole of this pathological histology completing the Diseases of Nutrition. The special forms of degeneration are little amenable to any *treatment* beyond the general indications already noticed.

(1.) Fatty degeneration presents certain general, yet distinctive characters—structural, physical, and, it may be, chemical. Examination with the microscope shows minute granules in the very substance of some structural element; be it a cell—in its contents, or in the place of its nucleus; if a primitive fibre—in its substance; if a simple membrane—in its substance: thus, in all cases substituting, at least in part, the original structural element, which has undergone this degenerative metamorphosis. These granules are particles of fat or oil; for being highly refractive, they are bright and glistening; they are soluble in ether; and they tend to coalesce into distinct drops of oil.

Proportionately as the oil-granules usurp the place of an elemental structure, its proper substance disappears. For example, a cell having become full of oil-particles,—a granule-cell, its walls disappear, leaving only a granule-mass; and these granules are apt to coalesce into drops of oil.

The interstitial tissue of the texture usually undergoes fatty degeneration simultaneously. And the disposition of *these* oil-granules is peculiar and significant. They are arranged, as Virchow observed in the liver, in the course of the capillary blood-vessels, which become thickly studded with particles of oil, as if deposited from the blood.

The general physical characters of a texture whose structural

elements have undergone fatty degeneration are these :—The texture is softened, or if soft in its healthy condition, it has now assumed a doughy consistence, which retains any impression or mould given by the fingers, as if it were soft putty; but this fatty texture is friable, greasy, burns readily and with a bright flame, and yields, by analysis, an unusual quantity of fatty matter. It has also acquired a dirty-brown colour, here and there mottled with a dead-leaf or wash-leather colour; these patches corresponding to the most advanced stage of fatty degeneration.

Muscular texture in the state of fatty degeneration well illustrates these physical characters; while the co-existing changes of minute structure are also well defined, and they are characteristic of this degeneration. I select the muscular texture of the heart, for its fibres being striated, they resemble and represent those of voluntary muscle. The fatty degeneration of this organ is also a most important question in the practice of Medicine and Surgery; and, I may add, in relation to Medico-legal Inquiry respecting the (natural) causes of sudden death.

The history of our present exact knowledge respecting fatty degeneration of the heart proves beyond a doubt that this condition of its muscular texture was for a long time confounded with the mere *interstitial* deposit of fat in the muscular substance of this organ. For the physical appearances of both these conditions are similar. They are those which I have just described, and they contrast with the healthy characters of muscular texture.

Portions of the heart, commonly of the left ventricle, have acquired a mottled yellowish appearance, chiefly visible on the interior or the external surface of the ventricle, immediately underneath the endocardium or pericardium. When viewed more closely, these spots present wavy transverse lines. Each spot is not abruptly defined, but tinted off into the adjoining healthy texture. If degeneration be incipient, these spots are yellowish brown; if advanced, they have assumed a dead-leaf colour. The muscular texture is no longer fibrous, but friable; and if the degenerative transformation be extensive, involving a considerable portion of the whole substance, the heart will have acquired a doughy softness, which retains any impression given by the fingers. The organ is palpably greasy, and its texture burns readily, and with a bright flame. Chemical analysis has shown that, in connection with this degeneration of texture, the quantity of fatty matter, and the proportion of olein to margarin, is much increased.*

Both ventricles are more subject to this degeneration than the auricles; but, although rarely, the muscular substance of the whole heart may undergo the same change.

The foregoing physical appearances had long since been observed by Laennec, and previously by Dr. A. Duncan, in 1816, and would even seem to have been known to Lancisi and Morgagni; but many such observations referred to fat, merely accumulated, on the surface of the heart, and deposited interstitially amongst its fibres. It was reserved for the microscopic researches of Rokitansky, Drs. C. J. B. Williams and Peacock, and more especially for those of Sir James Paget, Drs. Ormerod and Quain, to fully demonstrate the changes of structure

* See "A Chemical Investigation of the Pathology of Fatty Degeneration," by Mr. J. Peel. Appendix to "Address in Medicine," by Dr. E. L. Ormerod. "Brit. Med. Journ." 1864.

which the muscular fibres themselves undergo in fatty degeneration. By comparing the textural elements of muscle in a healthy state, these alterations of structure will be more clearly appreciated. The annexed figures represent the appearances of healthy muscular fibres taken from the hearts of a bullock and sheep, which I examined. Half a dozen fibres are presented in Fig. 63. The transverse striæ are well shown, and also the fibrillæ projecting from the end of each fibre. Similar appearances are seen in the fibres from the sheep's heart. (Fig. 64.)

Fig. 63.

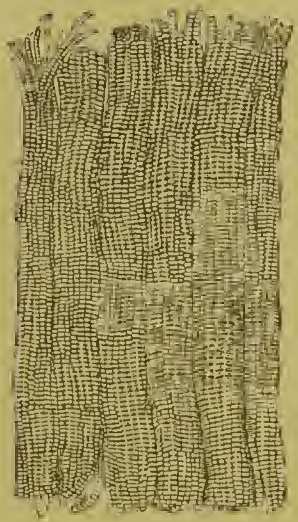
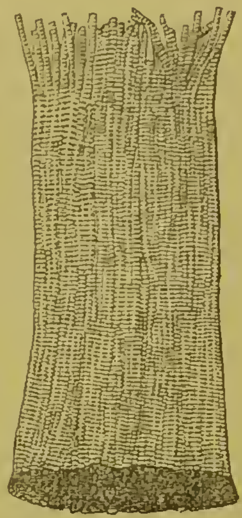
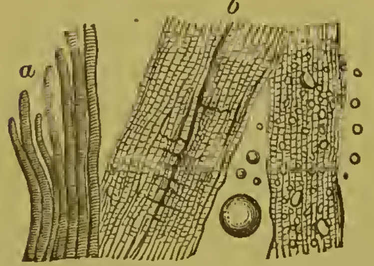


Fig. 64.



In fatty degeneration of the muscular fibres, a observed in the human subject, the earliest stage exhibits characteristic alterations. The fibrillæ evince a disposition to disintegrate, as shown by their readily splitting longitudinally and tranversely. (Fig. 65, *a* and *b*. Wedl.) The transverse striæ become less distinct, and oil-particles visible—*within* the sarcolemma of the fibres, and externally—besetting the fibres, a condition represented by the fibre to the right of *b* (Fig. 65); but this not an essential condition. The former may be termed *intra* oil-particles, to distinguish them from the latter, between the fibres, or inter oil-particles.

Fig. 65.



The intra oil-particles appear, firstly (Figs. 66 and 67), as minute granules, arranged transversely, as it were, across the direction of the fibres; thus corresponding to the *sarcous elements* whose place they occupy, and substitute, but from which they are readily distinguished by their bright glistening appearance, being highly refractive, and by their solubility in ether. Subsequently, in a more advanced stage (Fig. 68, or simultaneously in other adjacent fibres, the transverse striæ have entirely disappeared; the intra oil-particles have no definite arrangement; each fibre consists of oil-particles confusedly aggregated together, presenting a dim molecular aspect, in this respect somewhat

resembling the healthy appearance of unstriated organic muscular fibre. The bright glistening appearance of the aggregated oil-particles, and their solubility in ether, are still characteristic marks of distinction. Ultimately, the oil-particles have coalesced into distinct *drops*

Fig. 66.*

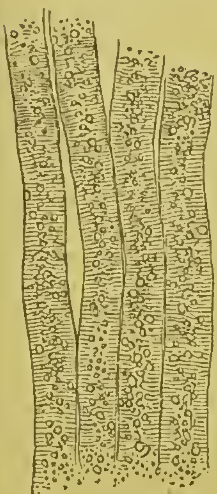


Fig. 67.*

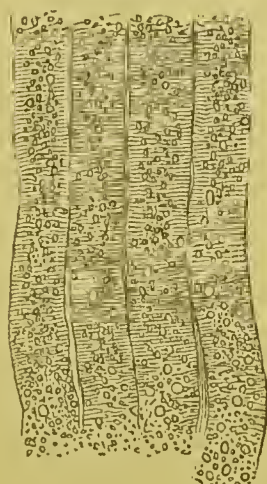


Fig. 68.†

Fig. 69.‡

Fig. 70.§

of oil (Figs. 69 and 70), some of which adhere to the interior of the

* Fatty degeneration of muscular fibres of heart in cattle, exhibited by the Smithfield Club as prize specimens of breeding and feeding, 1857.—*The Author.*

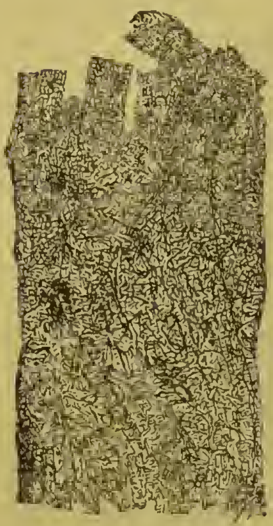
† Another prize specimen; the *best sheep*, of any long-woolled breed one year old, showing more advanced fatty degeneration of muscular fibres of the heart.—*The Author.*

‡ The *best* Devon ox, above three years old, showing most advanced fatty degeneration of muscular fibres of the heart.—*The Author.*

§ Muscular fibres of human heart, in most advanced fatty degeneration. (Wedl.)

sarcolemma, which still remains unbroken and enclosing them. The large oval nuclei, which are perhaps peculiar to the muscular fibres of the heart, have become obscure, or altogether disappeared. But no fat-particles or drops are commonly found between the fibres, and the absence of any interstitial fat is conspicuous, unless the sarcolemma has partially disappeared in the course of degeneration, or has been ruptured in displaying the fibres with needles.

Fig. 71.



In contrast with this degeneration, I have here represented the appearance produced by disintegration of the sarcous elements in the muscular fibres of the heart, (Fig. 71); showing the entire absence of transverse striæ, unaccompanied by the substitution of oil-particles. This transformation resulted from mal-nutrition, induced by dense thickening of the cardiac reflexion of the pericardium consequent on pericarditis, as represented in Fig 19, page 76. Sudden death occurred while turning in bed. (Royal Free Hospital).

Fatty degeneration is regarded as a *chemical* transformation.

It is alleged that this conclusion might be inferred from the fact, that in fatty degeneration of striated muscular fibre the oil-particles are primarily arranged in the same manner as the proper structural constituents, or sarcous elements of the fibrils, whose place they occupy. It is urged as a more direct proof, by Dr. Quain,* supported by Dr. C. J. B. Williams,† Paget,‡ Bennett,§ and by other distinguished pathologists, that fatty matters are produced during the spontaneous decomposition of nitrogenous substances, as the formation of adipocire in muscular tissue; instances of which are given by Virchow.‖ Then again, muscular tissue is converted into adipocire when macerated in water for some time; and this artificial production of fatty matter in muscular tissue was originally adduced by Dr. Quain, and since by the above-named pathologists and others, in confirmation of the chemical theory of fatty degeneration, by which muscle and other textures are transformed into fatty matter within the *living* body. But the carefully conducted experiments of Mr. Peel and Dr. Ormerod lead to the conclusion that, in the production of adipocire from muscle, the fatty matter is "not a newly formed substance, but a new arrangement of the old materials, a saponification of the fat already existing." Hence, that the chemical theory of fatty degeneration is fallacious, and that the *increased* production of fatty matter is a vital change,—that degeneration is a physiological or pathological process.

Fatty degeneration is apt to arise in connection with a general increase of fat in the body; a fact adverted to by Dr. T. K. Chambers,¶ as a casual coincidence in the human subject; and, I have shown this

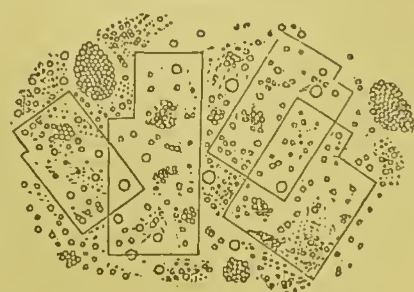
* "Med. Chir. Trans.," vol. xxxiii. p. 140, etc.
† "Principles of Medicine," 1856, p. 449 *et seq.*
‡ "Surgical Pathology," 1853, vol. i.
§ "Principles and Practice of Medicine."
‖ "Archiv," B. i. p. 167.
¶ "On Corpulence," 1850, pp. 120, 121.

connection in *over-fed* prize cattle,* and thence the fallacy of the *principle* of the English system of fattening cattle.

The blood-vessels are prone to fatty degeneration, which is then known by the name of *atheroma*.

The larger arteries are not unfrequently beset with flattened and slightly elevated patches on their inner surface, but underneath the thin lining membrane. This atheromatous matter is yellowish, opaque, of cheesy consistence, yet friable; and it consists of oil-particles with crystals of cholesterine (Fig. 72. Gulliver), which partially occupy the place of the middle muscular coat. Eventually, a further deposit ensues, consisting of mineral salts—probably phosphate and carbonate of lime, by which the atheromatous matter becomes hard and brittle, and the patches assume the character of calcareous or bony plates, but with a very imperfect imitation only of the structure of bone. The inner lining membrane may then give way, and the degenerate portion of artery having lost its elasticity, is disposed to yield to the pulsating throbs of the arterial wave-current, and expand into an aneurism. This series of degenerate transformations is especially apt to occur in some portion of the arch of the aorta; and in one remarkable case of aneurism of the transverse aorta, which I examined for my colleague, Dr. Cockle,‡ a no less remarkable condition co-existed:—the whole thoracic aorta was converted into a continued series of bony plates, forming a bony tube, which condition terminated abruptly at the aortic aperture in the diaphragm.

Fig. 72.†



The histological characters of fatty and calcareous degeneration of the larger arteries were discovered by Mr. Gulliver;§ but the smaller blood-vessels, arteries, veins, and capillaries are also liable to a certain transformation respecting which two opposite views are held.

The smaller blood-vessels (Fig. 73) may become studded with fatty granules, at first thinly and irregularly scattered, subsequently more thick set; or the oil-particles may aggregate into patches, sometimes oval or round, generally of an irregular shape; and these aggregated granules are apt to coalesce into drops of oil.

Fig. 73.‖

* "Evil Results of Overfeeding Cattle." 1857.

† Fatty particles, oil-drops, and granule-cells, with crystals of cholesterine; from broken-down atheroma of an artery. (Bennett.)

‡ Case read before Med. Soc. Lond., 1862.

§ "Med. Chir. Trans.," vol. xxvi. p. 86.

‖ Fatty degeneration of blood-vessels, illustrated by the cerebral vessels of an aged individual who died of apoplexy.—*a*, ultimate capillary; *b*, larger vessel; *c*, small artery, with fatty particles scattered over its surface. (Wedl.)

Now, the question is—Are these granules outside the vessels, or in the substance of their walls? Patches of granules were described and figured by Dr. J. H. Bennett * in 1842, and attributed to fatty degeneration of exudation-matter, thrown out from the vessel. In 1849, Mr. Paget † also described the same appearances, but attributed them to fatty degeneration of the vessels themselves. These latter observations referred to the smallest cerebral vessels, in connection with apoplexy, and softening of the brain, respectively. He describes the fatty granules as being situated "beneath the outer surface" of the vessels. That in small arteries of $\frac{1}{500}$ of an inch in diameter, the granules are formed in the more or less developed muscular or transversely fibrous coat; in veins, the corresponding layer, immediately within their external fibro-cellular nucleated coat; in vessels, whether arteries or veins, whose walls consist of only a simple pellucid membrane, bearing nuclei, the substance of this membrane is the first seat of the fat deposit. As this degeneration proceeds, the portion of vessel thus affected undergoes changes of structure, the nuclei and fibres disappearing, until at length blood-vessels of $\frac{1}{150}$ of an inch in diameter appear like tubes of homogeneous pellucid membrane, studded with oil-particles, in its substance. By this change, the proper structure of the vessels wastes, and eventually disappears, giving place to the fatty granules. Alterations of shape, also, are not uncommon. Usually, the outer layer of the wall is lifted up by one or more clusters of oil-particles, and the outline of the vessel becomes tuberous. Sometimes aneurismal dilatations form.

This fatty degeneration of the smaller blood-vessels occurs most frequently in arteries of $\frac{1}{150}$ of an inch in diameter; veins of the same size, or smaller, are next in order liable; and capillaries, least so.

A similar degeneration of the blood-vessels of the lungs has been observed by Dittrich, and in branches of the pulmonary artery, accompanied with tuberculous disease of the lung, by Dr. R. Hall.‡ The placental blood-vessels often exhibit a similar transformation; and those of the eye, in connection with arcus senilis.

Fatty degeneration of the cerebro-spinal substance, and of nerve-fibres, is questionable. The brain or spinal cord may liquefy or soften, partially, or throughout its whole substance, with breaking up of the nerve-fibres, and the production of abundant granule-cells or masses, and free-floating granules; but these changes are collectively denominated by Paget "liquefactive degeneration:" and this arises from obstructed circulation through the substance of the organ, or from abrogation of its function. Atrophy of nerve-fibres is thus described by Waller:—At first transverse lines appear in the intra-tubular substance, indicating its loss of continuity; then it is apparently divided into round or oblong coagulated masses, as if its two component materials were mingled; they are converted into black granules—resisting the action of acids and alkalies; and finally, these granules are slowly and imperfectly eliminated.

Besides fatty degeneration of textures, the healthy integrity of which is most essential to life, this transformation may occur in perhaps any other texture. In the air-vesicles of the lungs, and in the

* "Edin. Med. and Surg. Journal," vols. lviii. and lix.

† "Medical Gazette," vol. xiv.

‡ "Med. Chir. Rev.," October, 1855.

bronchi (Bennett); * in the cells of the liver—hepatic cells—constituting fatty degeneration of that organ; in the shut sacs of vascular glands, as those of the spleen (Bennett); in the pancreas (C. J. B. Williams); † in the kidneys, as first shown by Bowman; and generally in the ducts of all glands which are lined with epithelium. The stomach, intestine, and urinary bladder, are probably not exempt; their fatty degeneration being a further illustration of this process, chiefly as regards organic muscular fibres. By a similar transformation of the uterine substance after parturition, this organ regains its former dimensions, or nearly so. The placenta often passes into fatty degeneration—so named by Dr. Barnes, and originally figured by Dr. J. H. Bennett, in 1844,‡ who regards the fatty molecules and granule-cells, not as produced by a transformation of the placental tissue, but of exudation-matter, or by that of extravasated blood. "The yellowish or fawn-coloured deposits may be infiltrated throughout the tissue of the placenta over a greater or less space, or they may occur in isolated spots forming nodules. They are generally somewhat indurated, and give rise to the idea that they are coagulated fibrin. I (Dr. Bennett) have frequently examined them, and traced all the changes intermediate between a coagulated exudation, or extravasation of blood, and the ultimate conversion of the foreign matter into a mass of molecules filling up the intervascular spaces. Similar observations have been more recently made by Drs. Hanfield Jones § and Cowan.‖ In many cases the fatty material may be seen forming a layer separate from the vessel, and inside the limitary membrane of the villus."¶

Bones are liable to fatty degeneration of their texture; a condition corresponding to the "mollities ossium" of most English authors. The characteristic properties of the osseous texture in this state are—its softness and brittleness, pale yellow colour, oily greasiness, and lightness; the texture being that of a spongy bone deprived of its earth, and soaked in soft fat, while the original size and shape of the bone remain unaltered. Hence the name—Eccentric Atrophy of Bone—proposed by Mr. Curling, as suggesting one of the most striking characters of this transformation. Oil, not fat-cells, fills the cancelli, and is even found in the lacunæ and canaliculi (Virchow). Combined with this oil, Bennett describes numerous cells, each of which varies in size from $\frac{1}{1200}$ to $\frac{1}{500}$ of an inch in diameter, and contains a round nucleus, also varying much in size, and occasionally showing various stages of division and of endogenous development. The production of this cell—as in most of the so-called fatty *degenerations* of texture, according to the same observer—is attributed to an *exudation* from the blood-vessels, mingled with more or less of the coloured corpuscles, in which new cells are developed, combined with fatty transformations of the albuminous and fibrinous materials; thus differing from the structural condition of bone, known as "rachitis," which, although also accompanied with softening, is regarded as arrested development of bone, with increased growth of cartilage-cells (Kölliker).

* *Op. cit.*, p. 234. † "Principles of Medicine," p. 448.
‡ "Treatise on Inflammation," plate, Fig. 10.
§ "British and Foreign Med.-Chir. Rev.," vol. ii. p. 354.
‖ "Edin. Med. and Surg. Journal," April, 1854.
¶ "Principles and Practice of Medicine," 1859, p. 238.

Cartilage is prone to true fatty degeneration; oil-particles, and by coalescence, oil-drops, substituting the contents of the cartilage-cells; during which transformation the nucleus vanishes. Oil-particles may likewise beset the intercellular hyaline basis; which, together with the cell-contents, acquire a marked opacity.

"Arcus senilis" consists of oil-particles in the substance of the cornea, near the iris, forming a marginal ring round it. This fatty degeneration was discovered and originally described by Mr. E. Canton.* Its significance extends far beyond the organ of vision, whose function remains unimpaired; for, unless consequent on inflammation of the eyeball, arcus senilis is the pathologico-anatomical indication of many other and most important co-existing fatty degenerations,—of the ophthalmic artery, of the muscles attached to the eyeball, of the heart; and, in fact, a degenerative tendency throughout the body. Thus, a well-marked arcus, in both eyes, is the surest external and visible sign, during life, of internal and unseen fatty and other degenerate conditions of organs, discovered after death. Arcus senilis was present in about $\frac{9}{10}$ of the cases in which Dr. C. J. B. Williams had reason to infer the existence of fatty degeneration of the heart. And although commonly seen, as the term implies, only in advanced life, the arcus in earlier years is, apart from local disease of the eyeball, a sure indication of premature old age. The lens is sometimes transformed into fat (Dalrymple, Lebert), constituting soft cataract.

New Products—*i.e.*, false tissues, deposits or exudations, and growths—are by no means exempt. A pleuritic false membrane, for example, may be converted into fatty matter. Of deposits, pus-cells are especially prone to fatty transformation of their contents, forming granule-cells; tubercle-corpuscles disintegrate, in the softening of tubercle. Among growths, cancer is apt to become studded throughout its substance with oil-particles, free, and *in* the cells, which are then no longer distinguishable as "cancer-cells." Eventually the cell-walls disappear, and the whole or portion of the growth which has thus degenerated, becomes a confused mass of fatty matter, with the remnants of cells. It is worthy of note, that the fatty matter may appear in yellow masses, not unlike softened or yellow tubercle, and that this resemblance explains some instances of the so-called co-existing admixture of tubercle with cancer.

(2.) Pigmentary is akin to fatty degeneration; the material deposited in either case being *essentially* carbonaceous; in the one, oil-particles or drops; in the other, pigment-particles or granule-masses of pigment: but the origin of this pigment-matter is different in different cases; and its pathological significance is therefore equally diverse.

Pigment-matter may represent the colouring matter of the blood, or of the bile; and these being distinct sources, refer to morbid conditions of origin, as distinct; but the particular colour of the pigment deposit—commonly black, sometimes red, brown, green, or yellow—does not enable us to determine with precision the question of origin.

Carbonaceous matter introduced into the body, and deposited in

* "Observations on Arcus Senilis," *Lancet*, 1850-51.

the textures, is obviously not pigmentary degeneration. Such is the black matter found in the lungs and bronchial glands of colliers and others who habitually inhale smoke. The colour of this matter is not discharged by hydrochloric acid or by chlorine; a point of distinction between it and the pigment of morbid origin, which disappears under the influence of these chemical agents.

Pigmentary degeneration occurs frequently in the mucous membrane of the stomach and intestines of old persons, and is recognized by slate-coloured discoloration of this texture. So also in cases of dysentery. Of new tissues, intestinal cicatrices not unfrequently present the same appearance. Deposits of tubercle eventually become surrounded with black pigment-matter. New growths may be infiltrated with this matter, as commonly occurs in encephaloid cancer; or pigment may be deposited by itself, and accumulate in the form of a distinct tumour, as melanosis.

(3.) Fibrous degeneration would appear to be an evolution of one structural constituent of the transformed texture—the fibrous element—at the expense of another constituent, which itself has undergone degeneration and disappeared; leaving its surviving companion more conspicuous, and the representative of the originally compound texture transformed as if entirely by degeneration.

Muscles are the chief seat of this fibrous transformation, and especially the voluntary muscular texture. In the course of that general and natural wasting of the body which denotes old age, the voluntary muscles especially become paler and more fibrous, as seen after death; though softer, because less contractile, during life. This senile atrophy is characterized by wasting of the muscular fibres, while the interstitial fibro-cellular tissue thus becomes more apparent, forming a condensed sinewy texture, instead of muscle. As felt during life, the tendons seem to have encroached upon and substituted the muscles. By this shrinking, and by that consequent on the disappearance of subcutaneous fat, the rounded outline of youth is lost in the shrunk shanks of the lean and slippered pantaloon.

Apart from this textural transformation incident to age, it is questionable whether fibrous degeneration occurs otherwise than by the deposit of interstitial exudation-matter. The muscular texture is still a chosen seat. Of voluntary muscles, those of the limbs may acquire a fibrous condition, as the result of chronic fascial rheumatism; the intercostal muscles and diaphragm also, in chronic pleurisy; while fibrous degeneration of organic muscular texture is exemplified by that of the heart after endocarditis or pericarditis. Membranous textures likewise are peculiarly liable to this change, apparently by interstitial deposit. Hence, probably, the opaque white thickenings of serous membranes which are seen as patches in the cardiac reflexion of the pericardium, in the valves of the heart, in the pleura, in the peritoneum, especially over the liver, and in the arachnoid. Other accredited examples of fibrous degeneration are certain indurations produced by interstitial fibrinous effusions, as in the interstitial cellular tissue of parenchymatous organs—the liver, kidneys, spleen, or lungs—constituting cirrhosis; or in the submucous or subcutaneous cellular texture; the latter, so-called degeneration, being that induration of this tissue which is occasionally witnessed in a newly-born infant.

Fibrous degeneration, or induration of parenchymatous organs, takes place at the expense of their proper structure, which atrophies and partially disappears.

(4.) Amyloid, waxy or lardaceous degeneration, is probably allied to, if not a variety of, the fibrous degeneration. The texture affected acquires considerable firmness and density, is somewhat transparent, and of a yellow or yellowish-brown colour, which in many cases contrasts with the colour of the original texture. The cut surface is not unlike that of firm bacon. Thus, the liver, the kidney, or the spleen, having acquired these characters, is then said to be in a state of waxy degeneration. The essential structure of the tissue or organ atrophies;—the secreting cells of the liver or kidney, and its malpighian bodies, wither; at the same time these cells present a remarkably pale and transparent appearance, as they become insignificant. The corpuscles of the spleen, both in its parenchyma and in its malpighian bodies, shrivel, and have also a similar appearance.

Amyloid degeneration is apparently due to interstitial exudation-matter. This material is unorganized; it is itself translucent, but presents a dull surface, at first of a greyish tint, afterwards perfectly colourless; it belongs to the albuminoid group of organic chemical compounds, but its precise composition and chemical relations are unknown. If deposited in a free state, amyloid matter appears in the form of "corpora amylacea," bodies which are concentrically laminated, like starch-granules; as found sometimes in the nerve-centres. Pure amyloid matter assumes a blue colour by the action of iodine; and this fact, first observed by Virchow,* led him to conclude that the waxy material in question was similar to starch, and therefore hydro-carbonaceous. He accordingly named it "animal amyloid." Meckel regards the amyloid matter as fatty, and especially cholesterine; he therefore retains the name, lardaceous or cholesterine disease: but Friedreich and Kekulé † have ascertained that the composition of the purest amyloid matter obtained from the spleen closely resembles that of the albuminous principles; and this conclusion is confirmed by the independent analysis of Schmidt.‡ Yet the chemical reaction of amyloid being unlike that of albuminous matter, the material itself is so far peculiar.

Ordinary albuminous matter is rendered yellow by iodine; and this reaction explains the different shades of colour produced, when a texture is submitted to the influence of iodine,—as a test for amyloid degeneration. The blue and yellow colours present the resultant colour—green; its shade, however, varying with the different proportions of the normal albuminous and amyloid matters. Thus, there are cases, observes Virchow, where throughout the whole extent of the digestive tract, from mouth to anus, the small arteries of the mucous membrane are affected with amyloid degeneration. The intestines are pale grey, translucent, and may have a slightly waxy appearance. Apart from microscopic examination, the nature of this change might not be discerned. But the iodine test supplies a ready method of detection. Brush a little iodine upon such mucous membrane, and a number of densely aggregated yellowish or brownish-red spots are soon seen to

* "Archiv f. Path Anat.," Bd. vi. s. 135, 268, and 416. † Ibid., Bd. xvi. s. 50.
‡ "Annal. d. Chemie und Pharmacie," Bd. cx. s. 250.

start up, leaving the intervening mucous membrane merely yellow. These points are the amyloid degenerate villi.

Waxy and fatty degenerations are frequently combined, as in the liver and kidney respectively; but a series of analyses, chiefly by Dr. Drummond, and collected by Gairdner,* has elicited this important general result:—that the human liver in the state of waxy degeneration contains considerably less fat and water, and a greater amount of solid constituents, than in the healthy state.

(5.) Granular degeneration is manifested by an albuminous matter —granular, *i.e.*, structureless, and, it is said, *deposited* interstitially; but superseding the proper structural elements of the texture, which atrophy and disappear. Thence the original texture becomes converted into a granular mass. With this degenerative transformation, the texture loses its cohesion, and also acquires an opaque yellowish colour. It is apparently identical with what Bennett denominates "molecular albumen," and a variety of "albuminous degeneration." I am inclined to regard this degeneration as being, more correctly speaking, a disintegration of the structural elements of the original texture, without the deposition of any new granular or molecular albuminous matter. It chiefly affects the fibrous textures or fibrous new formations; either of which by their disintegration would yield this kind of matter, and present the physical characters of yellowish opacity and want of cohesion already noticed.

(6.) Calcareous degeneration—the lowest form of all—approximates organized textures to unorganized concretions. The new matter consists of phosphate of lime and magnesia, and carbonate of lime. This matter also is said to be *deposited* interstitially in the original texture, the structural elements of which, having atrophied, are gradually superseded; thus completing that substitution of texture which constitutes a degenerative transformation. Rokitansky regards calcareous degeneration as a chemical precipitation of the apparently new mineral matters from their natural combinations with the animal matters of the texture. This view is analogous to what I have denominated the disintegration of *organized* matter; and still more so to degeneration by absorption of one structural constituent of a compound texture, and thence the evolution of another such constituent.

Calcareous degeneration takes place in tissues of simple organization and of low vitality in respect of blood-supply and nutrition. For example, in fibrous textures, in cartilage and fibro-cartilage, and in bone; the mineral transformations of these textures constituting that natural petrifaction whereby, as age advances, the body is slowly yet surely reduced to its primitive earth. But this degeneration is not unfrequently *secondary* to some other; commonly consequent on the fatty metamorphosis, and of the arteries, principally. Atheroma in the coats of these vessels, or in the valves of the heart, is followed by calcareous degeneration, so that both become associated in the same portion of texture; as was noticed in connection with fatty degeneration. The calcification of nerve-texture is seldom met with in the human species. Of deposits, tubercle is most liable to calcify, as in the pulmonary texture, and the tuberculous matter deposited in the bronchial and lymphatic glands. This change would seem to arise

* "Monthly Journal of Medical Science," May, 1854.

from absorption of the animal or albuminous matter of the deposit, and precipitation of the associated mineral constituents. The same change may occur in exudations on serous membranes, forming osseous-like or calcareous plates, as on and in the pericardium, and in parenchymatous organs, forming calcareous concretions. Morbid growths of all kinds are liable, and some are prone, to calcification; fatty tumour, sometimes fibrous, or cystic tumour; cartilaginous tumour, very commonly; cancer, not unfrequently. And in all cases, this degeneration arrests the further progress of growth, and is a natural mode of cure.

Regarding Degeneration, of whatever kind, as a *process* resulting in the transformation of the structural elements of textures and organs, this process may take place in apparently *three* different ways, representing as many *modes* of degenerative transformation.

This change of textural structure may issue from (1) the deposition of new matter, which *directly* substitutes the proper structural elements of the texture undergoing degeneration, they having disappeared; or (2) degeneration may proceed from *chemical* transformation of the proper structural elements, or again, from similar transformation of exudation-matter, *interstitially* deposited. These modes of degeneration are illustrated by fatty degeneration. Pigmentary degeneration, properly so called, I have restricted to the deposition of pigment-matter from the blood or from the bile. Fibrous degeneration, in its typical form, I have regarded as (3) the evolution of fibrous tissue, by the atrophy and disappearance of another and more essential structural constituent of a compound texture; as in muscle, the muscular fibres disappearing, this change evolves and exhibits their interstitial connective tissue, which becoming condensed, readily assumes the character of fibrous tissue. The actual conversion of muscle into fibrous tissue is the received view of fibrous degeneration. Obviously, however, this change cannot be effected by conversion of the muscular fibres,—for they have partially or entirely disappeared; but it may occur from the more or less complete substitution of *interstitial* exudation-matter, which assumes the fibrous character. This is the acknowledged mode of amyloid degeneration, and the new matter *interstitially* deposited seems to be chemically allied to that of fibrous degeneration in having an albuminous nature, while structurally it differs in being granular or structureless. Granular degeneration is also said to take place by the disposition of new matter *interstitially*; as another form of albuminous material, which gradually usurps the place and substitutes the structural elements of the original texture, and thus completes this degenerative metamorphosis. I have regarded it as a process of Disintegration of the structural elements, without the deposition of any new matter; and that the granular matter is formed chiefly by the breaking down of textures originally fibrous, or by that of fibrous new formations. Calcareous degeneration is an analogous process; being either a chemical precipitation of saline matters from their associated albuminous matters, or possibly the deposition of new calcareous matter, *interstitially*, with absorption and disappearance of the albuminous matter.

These Transformations—degenerative and disintegrative—of textures, original and adventitious, are represented in the following table:—

RETROGRESSION OF THE STRUCTURAL ELEMENTS OF TEXTURES.

(1.) By the deposition of new matter—
- *a.* Directly substituting the original structural elements, which have themselves disappeared.
  Fatty and Pigmentary degenerations, respectively.
- *b.* Interstitially deposited, and accompanied with the absorption and disappearance of these elements.
  Fibrous, including amyloid or waxy degeneration.
  Granular degeneration.
  Calcareous degeneration.

(2.) By chemical transformation—
- *a.* Of the original structural elements.
  Fatty degeneration of muscle. (Dr. R. Quain.)
- *b.* Of interstitial exudation-matter.
  Fatty degeneration, in many cases. (Dr. J. H. Bennett.)

(3.) By atrophy of one structural constituent of a compound texture, and the evolution thereby of another constituent. (The author.)
Fibrous degeneration of muscle. (The author.)

(4) By disintegration— (The author.)
- *a.* Of the original structural elements.
  Granular degeneration, so named, of fibrous textures.
- *b.* Of interstitial exudation-matter.
  Granular degeneration, so named, of fibrous new formations. By chemical precipitation, analogue of disintegration.
  Calcareous degeneration, so named. (Rokitansky.)

Retrogression of textural structure, by Degeneration—morbid, only when it occurs prematurely—represents, as I have said, the relapse or falling back from a higher condition, to a lower or more elementary grade of textural structure; and which substitutes the proper constituents of the original texture. This *relapse* and *substitution* are the essential characteristics of Degeneration.

CHAPTER IV.

ULCERATION AND ULCERS, GANGRENE AND MORTIFICATION.

Death of any part of the body, as contrasted with its nutrition, is essentially a disintegration of the constituent elements of structure and resolution into molecular matter; the destruction of the organization which resulted from development; the falling to pieces of that which the formative power had constructed. Disintegration, like Degeneration, therefore denotes both a process and its result in the destruction of structure.

Disintegration is related to Degeneration: the latter presupposes the former, but conversely, the former does not necessarily presuppose the latter; for Disintegration may occur independently, without any preceding Degeneration of texture.

Ulceration, and Mortification including Gangrene, are essentially processes of Disintegration and textural death. But the pathology of these processes, and their difference in degree only, should be clearly understood.

Ulceration is a disintegrative process, essentially; generally also of inflammatory origin. The molecular matter resulting from ulceration may disappear in either of two ways:—

Firstly.—By discharge, in the liquid form; thus leaving a chasm or *ulcer*.

Secondly.—By absorption through the lymphatics and veins jointly, especially the former vessels; thus leaving a chasm or ulcer.

Possibly, both modes of removing the disintegrated textures cooperate in ulceration.

Observe a case of common ulceration. The shin having come into collision with some blunt obstacle, receives a tolerably severe bruise. What probably happens? The bruised portion of integument becomes inflamed; in the course of a few days a small piece separates and comes away, leaving a chasm, from which more or less discharge of some kind issues; in fact, the skin, with perhaps the subjacent cellular tissue, has *slowly undergone* "solution of continuity," and an *ulcer* is formed. (Fig. 74.) Its formation and extension are termed *ulceration*.

The balance of evidence is, I think, decidedly in favour of the removal of the disintegrated matter by discharge. This matter can, indeed, be *seen* to come away occasionally; the molecular matter accumulating in the form of minute sloughs, whenever disintegration proceeds too rapidly for its discharge in the liquid form; and again disappearing as molecular matter, when disintegration and discharge proceed evenly.

Hunter originated the doctrine of "ulcerative absorption"—a doctrine which eventually took firmer root than perhaps any other of Hunter's views. "When," says he, "it becomes necessary that some whole living part should be removed, it is evident that nature, in order to effect this, must not only confer a new activity on the absorbents, but must throw the part to be absorbed into such a state as to yield to this operation;" and among the circumstances which lead to absorption, Hunter enumerates "*death* of the part."

Now, the possibility of dead tissue being removed by ulcerative absorption is demonstrated by the appearances which necrosed bone presents when a portion has been exposed, and the remaining portion for a time surrounded by living textures. For example, the shaft of the femur having become necrosed, the *sequestrum* loosens and eventually separates, or is easily taken away with the forceps. If, during the process of separation, part of the sequestrum has been exposed, that portion is seen to be smooth and polished, while the remaining portion which has been enclosed in new bone is seen to be *worm-eaten*, obviously, under these circumstances, from absorption. So also dead bone, artificially inserted into living bone, is in time partially absorbed.

New blood-vessels are developed around a sequestrum, apparently to meet the increased demands on absorption. Mr. Aston Key called

attention to this fact when first he advocated the doctrine of ulceration by absorption through the veins, rather than by the lymphatics, as Hunter had alleged. "When," says Mr. Key,* "the sequestrum is removed from its case of new bone, and the interior of the latter is exposed to view, a number of flocculent bodies are seen attached to a membrane that supplies the newly formed bone. When injected, these are shown to be highly vascular, and are seen to fill the indentations in the dead bone. If the latter be carefully taken out of its case of new bone, these vascular elongations will be found to have a slight *attachment* to those parts of the dead bone in which they are embedded."

The absorbent function of this new vascular apparatus is in accordance with other facts of similar import. Thus, Sir A. Cooper † possessed an injected preparation of an ulcer of the leg, in which the veins were developed in a remarkable manner. They were numerous and large, and *surrounded the margin of the ulcer.* In another preparation of ulcer of the leg the lymphatics were injected, but they appeared to be neither increased in size nor in number.

These observations prove the possibility, and even the probability, of ulceration by *absorption;* yet this view of ulceration is overruled by two series of facts.

Before stating them, I may mention a kind of compromise of the question at issue, and which I allude to chiefly on account of the general accuracy of observation which its distinguished author, Professor Goodsir, has evinced. Goodsir maintains, or did maintain,‡ that ulceration is a process independent of the vessels, both veins and lymphatics, they being "passive agents, mere ducts for conveying away the products of action.

"A rapidly extending ulcerated surface appears, as if the textures were scooped out by a sharp instrument. The textures are separated from the external medium by a thin film. This film is cellular in its constitution, and so far it is analogous to the epidermis or epithelium."

It is alleged that this cellular layer possesses the peculiar (vital) power of disintegrating the subjacent texture, and that by virtue thereof, so far from ulceration denoting a diminution of the formative power of the part, progressive ulceration represents its undue activity. "The apparent diminution is a consequence of the extremely limited duration of existence of the cells of the absorbent layer, which die as rapidly as they are formed, disappearing after dissolution partly as a discharge from the surface, but principally through the natural channels by which the *débris* of parts which have already performed their allotted functions are taken up into the organism.

"In this view of ulceration there is substituted, for the hypothetical active or aggressive power of absorption ascribed to the veins and lymphatics, a power which is known to exist in the organic cell during the progress of its growth; and the ultimate removal of the matter from the scene of action is ascribed partly to the formation of discharge, partly to the yet unexplained, but at the same time undoubted, and in all probability passive, agency of the returning circulation."

* "Med.-Chir. Trans.," 1833, vol. xviii. p. 215.

† Ibid., vol. xviii. p. 212.

‡ "Anatomical and Pathological Observations," by J. Goodsir and H. D. Goodsir, 1845, p. 14 *et seq.*

I am not in a position to offer any direct evidence against ulceration by absorption in this sense; but I recur to the two series of facts to which I have alluded—the one series disproving absorption in any sense, the other demonstrating the disintegration, liquefaction, and discharge of disorganized textures in the process of ulceration, and this *apparently* without the intervention of any cellular layer, as described by Goodsir.

In the first place, respecting ulceration without absorption. The veins proceeding from an ulcerated part are obviously much congested in certain cases, and therefore do not allow of that free passage of blood which venous absorption implies. A common varicose ulcer of the leg is a good illustration; and, as regards the lymphatics, ulceration may occur in a texture destitute of these vessels, or at least in which they have hitherto been searched for unsuccessfully. Ulceration of the cornea is a familiar example. Its conclusiveness is impaired by the presence of lymphatic vessels in, or immediately beneath, the conjunctiva. This anatomical fact was, I believe, first observed by Dr. Sharpey, who states * that he has distinctly seen lymphatic vessels, distended with their own lymph, on the surface of an eye which had repeatedly suffered from chronic inflammation. Again, Mr. Gaskell † has brought forward certain facts which are inconsistent with the theory that ulceration is absorption by the lymphatics. Thus, ulceration does not appear to be most common where the absorbents are most freely distributed. They are more numerous and of greater size in the jejunum than in the ileum, yet ulceration is rarely found in the former portion of intestine. The absorbents are freely distributed on the surface of the body, yet spreading ulceration does not extend so readily on the external surface as a little below. Lastly, absorption readily takes place from the surface of serous membranes; nevertheless, their inflammation is rarely followed by ulceration.

The independence of ulceration and absorption, whether by the veins or lymphatics, is I think, further established by another species of evidence. "If," as Key remarks,‡ "the formation of an ulcer be an act of absorption, the parts that are removed in the formation of a chancre are so disposed of; the absorbents, in forming a chancre, carry into the system tissues tainted by the venereal poison, and must therefore, in every instance, contaminate the whole mass of circulating fluids. A bubo, therefore, ought to be one of the *earliest* accompaniments of chancre. Whereas, during the ulcerative stage of chancre, the glands in the groin usually remain free from infection; it is when the ulcerative stage is at an end that the gland enlarges and bubo forms. In other words, when the absorbents are most actively engaged in producing the ulcer, and in carrying the poisoned mass into the gland, the latter exhibits no sign of irritation; but when the absorbents are inactive, the gland begins to enlarge." Furthermore, as Wallace § truly alleges, if "ulceration implies absorption, contamination of the system should *always* follow a chancre," unless, indeed, we assume that the venereal poison may be received into the mass of circulating fluids, without necessarily causing constitutional disease, an admission which we are not warranted in making.

* "Elements of Anatomy," 1848, vol. i. p. 260.
† "Jacksonian Prize Essay," 1837. MS. Roy. Coll. Surg. Eng.
‡ *Op. cit.*, 1835, vol. xix., p. 141. § "On the Venereal Disease," 1838, p. 51.

Duly considering the anatomical facts which I have adduced, namely, the condition of the veins in certain cases of ulceration, and the absence of the lymphatics in other cases; also, the fact that contamination of the blood is neither a constant sequent of primary venereal ulceration, nor, in its order of sequence, consistent with the hypothesis of absorption; the fair inference is, that ulceration may begin and continue without absorption.

Other facts show that ulceration is a process of *disintegration*, *solution*, and *discharge* of disorganized textures. Take, again, the ordinary case of an ulcer arising from a blow on the shin. In the course of a few days, a small portion of dead tissue—a *slough*—comes away. Its discharge announces ulceration. Dead texture *can*, as we have seen, be absorbed, yet this slough is discharged. It may be urged that in such case sufficient time is not allowed for absorption; that the tissue dies too extensively and too rapidly for the process of absorption to keep pace with that of destruction. But subsequently, as ulceration continues, a similar discharge of dead tissue continues. This discharge of textures may be recognized when now and then they die too rapidly to dissolve as they die, and thus become imperceptible. In all sloughing ulcers, whether from inflammation or fast-spreading phagedæna, the disintegrated portions of texture are visible. On the other hand, the common indolent ulcer and the varicose ulcer, also indolent, are generally free from the *débris* of the textures, which, as they have died, have been disintegrated, dissolved, and discharged. This, at least, is the fair inference; for every intermediate degree of disintegration and solution of the textures is witnessed, from the most obvious *sloughs* down to *débris* and all the varieties of *mixed discharge.*

This view of ulceration is supported by Mr. Key's observations, at the later date * referred to; by the observations of Earle,† Gaskell,‡ and Wallace.§ Mr. Paget,‖ also, has collated much important evidence in the same direction. Thus, in ulceration of cartilage, inflammatory exudation has no share, and the process of ejection of the disintegrated tissue may be clearly traced; but of cartilage it may be said, being extra-vascular, absorption cannot take place. The same process of ejection, however, is discernible in ulcerating bone (where absorption may occur), as shown by the observations of Virchow; and Bransby Cooper ¶ noticed, that while in pus from soft parts only traces of phosphate of lime are found, the pus from around diseased bone contains in solution nearly *two* and a *half per cent.* A similar, but less complete, observation was made by M. T. Taylor,** and also by E. von Bibra.††

Then, again, this view of the pathology of ordinary ulceration harmonizes with the process by which a *specific* ulcer is seen to be formed. Earle ‡‡ pointed out the sameness of the process. An incipient chancre is a vesicle which, bursting, discovers a minute slough.

* Op. cit., vol. xix. "Further Remarks on the Ulcerative Process," p. 135.
† "On the Nature of Inflammation," *Med. Gaz.*, 1835, vol. xvi. p. 254.
‡ "Jacksonian Prize Essay," 1837. MS. Coll. Surg. Eng.
§ "Venereal Disease," 1838, p. 48 *et seq.*
‖ "Lectures on Surgical Pathology," 1845, vol. i. pp. 420, 453.
¶ *Med. Gaz.*, 1845, and "Lectures on Surgery, 1851, p. 127.
** "Diseases of the Bones," Stanley, 1849, p. 89.
†† "Chemische Untersuchungen verschiedener Eiterarten," 1842, p. 85.
‡‡ *Op. cit.*, p. 254.

Its separation occasions the first loss of substance; subsequently, molecular disintegration continues the process of ulceration; for, as Wallace * observed, if a venereal ulcer be examined with accuracy, a red margin is seen, and frequently on the inner side of this margin a white line; the red margin in advance denoting the inflammation which precedes ulceration, and the white line within, the texture which was red, but is now white, having been converted into a slough *before* liquefaction and consequent separation. Minute sloughing, occasionally recurring on the surface of a venereal sore during the progress of ulceration, again suggests the true explanation of this process; molecular disintegration of the textures, being now and then exaggerated to visible sloughing of portions of them, declares the sameness of the process.

Degeneration precedes the disintegration, when consequent on inflammation. The degeneration connected with inflammation, unattended with ulceration, is usually fatty. Thus it takes place in muscles, as shown by Virchow's observations, and perhaps in muscular tissue of the involuntary order, *e.g.*, the heart, as in a case of fatal traumatic pericarditis examined by Mr. Paget; in bones, in the liver, and the kidneys, as shown also by Virchow; in the cartilages, as noticed by Redfern; and in the cornea, by Strube. Calcareous degeneration may be the prior textural change. It takes place in chronic rheumatic arthritis; with inflammation of the laryngeal cartilages; and the formation of imperfect dentine, with inflammation of the tooth-pulp, is, perhaps, another illustration.

Cell-infiltration of the surrounding tissue, with hyperæmia, usually also precedes the enclosed disintegration of tissue. (Billroth.)

The proper discharge from an ulcer—the product of ulceration, not that of a granulating sore—is ichor, the nature of which is not well understood.

Ichor is usually a thin sanious fluid, colourless or slightly yellow; structureless, but mixed with exudation, pus, and blood corpuscles, and with the disintegrated matter or *débris* of the textures. Its chemical composition, as to the essential constituents of this fluid, is unknown. Its chief property is corrosiveness; the operation of ichorous discharge maintaining and extending ulceration.

Diagnostic Characters of Ulcers.—An ulcer differs widely in appearance. Ulceration forms a chasm of very variable extent and depth, from the slightest abrasion of the integument to the deepest cavity down to and into the bone; its shape circular, crescentic, or irregular; it is found less frequently bare, than accompanied with sloughy portions of tissue, or with granulations of some description, overspreading the whole or part of the surface. The circumferential margin of the ulcer varies in thickness, and in direction; being turned inwards and perhaps undermined, everted, irregular, or tolerably even; it may be hard or soft; its colour and that of the surface may be red, dusky brown, livid, or otherwise shaded; while the ichor or discharge varies greatly in quantity and quality from the typical characters already stated, through every description of mixed discharge, replaced by healthy pus. The integument around may be healthy, inflamed, indurated, œdematous, or show pigmentary discolouration.

* *Op. cit.*, p. 49.

Causes.—All these different appearances proceed, generally, from constitutional conditions, as scrofula, scurvy, syphilis; but, occasionally, they are produced by external causes acting locally on the part; as by friction, continued pressure, filth, or various topical applications and dressings of an irritant character.

Two classes of ulcers, therefore, each including subordinate varieties, might be recognized with reference to their etiology; but, practically, it would be difficult to draw this line of distinction.

The *course* of ulceration is either that of progressive extension, in surface and depth; or that of healing by suppurative granulation and cicatrization, as the mode of reparation. (See Reparation by Granulation in Contused and Lacerated Wounds.)

Treatment.—Two general indications may be mentioned for guidance in the treatment of all ulcers; namely, to arrest disintegration, and to induce reparation. The measures, both local and constitutional, which may be appropriate for the fulfilment of these indications will be learnt in the treatment of the various species of ulcers.

The following species present, perhaps, the most distinctive characters:—

(1.) Healthy or typical Ulcer. (2.) Inflamed. (3.) Irritable. (4.) Œdematous. (5.) Indolent, and Varicose. (6.) Phagedænic. (7.) Hæmorrhagic. (8.) Scorbutic. (9.) Scrofulous. (10.) Cancerous. (11.) Lupoid. (12.) Syphilitic.

(1.) Healthy or Typical Ulcer may be consequent on a wound or other injury, or the separation of a slough; and the open sore thus formed, in a healthy person and itself in a healthy state, will be known by certain characters. Of variable extent, depth, and shape, the *surface* is uniformly mammillated with small florid granulations (Fig. 74), which, however, do not bleed readily and are not painfully sensitive. Healthy *pus*, opaque, yellowish, and of creamy consistence, more or less in quantity, bathes the granulating surface. The *margin* of this ulcer shelves gently down to its base, and is scarcely perceptibly harder than the adjoining healthy skin. The new skin, corresponding to the margin, has an opaque white colour, and its formation is preceded by a linear translucent film of cuticle, which, veiling the subjacent granulations, has a bluish-white tint. The granulations immediately within this line are more florid than those nearer to the centre of the ulcer, because more vascular where the cuticle and skin around are being formed.

Fig. 74.

The histological or textural condition consists of an abundant emigration of *cells*, infiltrating the connective tissue around the ulcer, and at the base of the granulating surface, where these wandering cells become granulation-cells, some of which pass off as pus-cells. There is also an increased development of *vascular loops*, especially in the papillæ around the margin of the ulcer, where the granulations are most vascular and florid; and the *papillæ* are themselves enlarged. Around the margin of the

ulcer, the *epidermis* is thickened, and perhaps indurated, forming a somewhat raised border, shelving down to the thin bluish-looking line of circumferential new cuticle. (Fig. 75.)

The surface having reached the level of the skin, by granulation, and the formation of pus—superfluous organizable material—having ceased; cicatrization proceeds inwards by the continued formation of

Fig. 75.*

marginal skin, preceded by cuticle, and thus, at length, exhibits the characters of healthy cicatrix, in the recent state. (See also Reparation by Granulation.)

Treatment.—Little or no positive treatment is requisite, a healthy ulcer healing spontaneously, provided any circumstances adverse to the process of reparation be excluded. Rest, position, to prevent tension and any undue determination of blood, and protection of the surface by water-dressing, are sufficient.

Skin-Grafting may be here noticed; a principle of treatment due to M. Reverdin, whereby the cicatrication of a granulating surface may be completed, and in a much shorter period than from the circumference alone; as when the ulcer is of large size, or indolent; or in order to prevent contraction of the cicatrix, as after burns, which would result in deformity and functional inutility of the part.

The procedure of skin-grafting is as follows :—A very small portion or particle of healthy skin is excised from some part of the body, as the thigh, and transplanted by laying it on the surface of a granulating ulcer, as on the leg; the particle of skin being there retained with a fine strip of adhesive plaster, or perhaps better, simply by overlaying it with a small piece of wet lint. The excision is easily accomplished by raising the bit of skin up with fine forceps, and paring it off with a scalpel, or snipping it off with sharp scissors; or an instrument, combining forceps and scissors, has been devised for this purpose. In removing the particle of skin, its depth should not extend into the subcutaneous fat, or produce hardly an appearance of blood from the spot. The surface of the granulations may be freshened with the point of the knife, and so as to imbed or graft the transplanted portion; but it is better merely to lay the particle of skin down, there retaining it in easy contact with a layer of lint. Several bits of skin may be thus grafted, according to the size of the ulcer. The changes which any such reproductive centre under-

* Cutaneous ulcer of the leg. Section magnified 100 diam. (After Forster.) —*a*, the cutis; *b*, the surface of the ulcer; *c*, the thickened and raised border of epidermis.

goes are, according to my own observations, apparently as follows:— The particle remains stationary or dormant for a few days, possibly even for some weeks, before beginning to grow; it may perhaps die away and nearly disappear as a thin, bluish-white point; then, if examined with a magnifying glass, a network of vessels will be seen in, and as a zone around, any cutaneous centre about to grow. The particle assumes an opaque white appearance, and loses its vascularity; it enlarges with a thin, semi-transparent, fringed border, preceded by the vascular zone, and increases also in thickness, thus growing both circumferentially and in substance from below. These changes of character are more observable in the reproduced portion of skin, the original centre remaining thinner and more transparent. Any such islet does not extend indefinitely, probably not to a larger size than a fourpenny piece or a sixpence. The areas of cicatrix, thus formed, meet together, or extend into the margin of the ulcer, and at length the surface becomes covered and cicatrization is completed. Skin-grafting sometimes succeeds or fails; and when practised in the same individual, at the same time, and in the same manner, on the same ulcer, some engrafted centres prove reproductive, others die out.

(2.) Inflamed Ulcer.—A departure from the healthy type of ulcer; the usual signs of inflammation are characteristic. An area of redness with some swelling around the ulcer are more or less conspicuous appearances, while a burning heat and aching pain are experienced, particularly when the part is pendent, as the shin—a common situation for an inflamed ulcer. The granulations have a rose-red rather than a florid colour, or they may be absent and the surface of the ulcer overspread with a thin ash-grey slough; the suppuration is scanty, thin, and perhaps tinged with blood. As inflammation subsides, the cuticle peels off or desquamates for some distance around the ulcer.

This condition of sore accompanies inflammatory fever, an ulcer previously healthy then becoming inflamed; or it may be produced by external violence or consequent on local irritation.

Treatment.—Any cause or causes in operation will, as usual, primarily direct the treatment, namely, their removal. Then, remedial measures are those appropriate for inflammation. A poultice, or a cold evaporating lotion, if more agreeable, and perhaps the local abstraction of blood by a few leeches applied in the neighbourhood of the ulcer; with rest and an elevated position of the part; and, finally, water-dressing as the sore assumes a healthy character and undergoes the process of healing. Bandaging the limb may, at this period, be useful to support the weakened vessels of the part; and thus prevent any liability to the continuance or recurrence of a low state of inflammation; a very troublesome chronic condition, which is apt to follow an acutely inflamed ulcer.

(3.) Irritable Ulcer.—This variety of ulcer is to be distinguished from an inflamed ulcer, with which it might be confounded. Painful to a degree, even of a neuralgic character, the other and more peculiar signs of inflammation, particularly circumferential redness and swelling, are wanting. The granulations are imperfect or absent, reddish here, tawny there; but they are very painful and sensitive to the touch, and readily bleed on slight pressure or the application of a

stimulant dressing. The discharge is thin and sanious; and the edge of the ulcer, irregular, sharp, and abrupt, evincing no disposition—not to say an obstinate indisposition—to commence cicatrization.

Commonly situated on the shin or lower part of the leg, an irritable sore or fissure of the anus also not unfrequently occurs, which well illustrates the pain and other characters of this variety of ulcer. It is generally connected with some disturbance of the digestive organs, and with constitutional irritation as distinguished from inflammatory fever. More rarely, some cause of local irritation may co-operate; as the passage of the fæces and the contraction of the sphincter-ani muscle with regard to irritable ulcer in ano.

Treatment.—The removal of any cause in operation is the primary consideration. Hence the rectification of the constitutional disorder, as by saline purgatives and mercurials to influence the secretion of bile. Then opiates, occasionally, will do much to allay the general irritability. Of topical applications, nitrate of silver freely applied is the most efficacious. Lead and opiate lotions may be recommended. Rest of the part is necessary or advantageous, as in the treatment of other ulcers; and thus, division of the sphincter-ani muscle by incision through a fissure of the anus, will relieve pain and facilitate granulation in that situation. In any case of irritable ulcer, as healthy granulations spring up, the pain subsides; and the cicatrix formed is not more than ordinarily sensitive.

(4.) Œdematous Ulcer.—In this variety of ulcer, the granulations are large, pale, translucent, and flabby, sometimes cropping up as large gelatinous masses above the level of the sore. The discharge is watery, and the margin has no disposition to commence cicatrization. Indeed, the granulations are apt to slough. This condition arises in connection with a weak circulation, or it may proceed from the soddening of an ulcer by continued poulticing or other prolonged application of moisture and warmth.

Treatment.—In addition to the removal of any constitutional or local cause, local treatment is often remarkably curative. An elevated position, astringent lotions, as of sulphate of zinc or nitrate of silver, and the support of a bandage, will probably succeed in reducing the granulations to the level of the ulcer, when exuberant, and strengthen their vitality, thus favouring cicatrization.

(5.) Indolent, and Varicose Ulcer.—A deep and, perhaps, large excavation, presenting a flat surface,—without granulations, of a dusky or pale colour, scarcely sensitive to the touch nor disposed to bleed, and having a firm, hard base adherent to the subjacent fascia. A thin offensive discharge exudes. The edges are everted, thick, and callous, and of an opaque-white colour, owing to accumulated epidermis; the surrounding integument to some distance is congested, of a dusky hue, and pigment-stained, thickened, hardened, and bound down to the textures beneath. Such an ulcer is obstinately indisposed to heal. It is commonly situated on some part of the leg.

An ordinary—non-specific—indolent ulcer does not seem to be dependent on any constitutional disorder; but it is apt to occur in weakly, ill-nourished, and perhaps ill-fed persons.

The *varicose* ulcer is a variety of indolent ulcer, and so named from its connection with the varicose condition of the adjoining veins. Resembling generally an ordinary indolent ulcer, it differs in certain

tolerably distinctive characters. Situated on some part of the leg, commonly on the inner side towards the ankle, and single; in the recent state it is of small size, ovoid shape, and with its long axis in the direction of the limb; without granulations and firm, a bluish-purple colour of the base and more so of the margin and adjoining integument will be noticed, and the ulcer is not unfrequently painful and sensitive. Inflammation and sloughing, or other conditions, may temporarily veil these appearances; but the tortuous, knotty enlargement of the venous trunks, or the more diffused mottling of smaller varicose veins, with, perchance, a brownish-red pigment-stained skin around the ulcer, is still a characteristic accompaniment. In the progress of varicose ulcer, an occasional event of practical importance is venous hæmorrhage; arising from the ulceration having penetrated an enlarged vein, it may occur suddenly and copiously.

Treatment.—An indolent ulcer cannot cicatrize so long as it and the surrounding integument are both bound down; the margin being upraised and retracted, and the base depressed. Accordingly, pressure and stimulation conjoined, represent the plan of treatment. The nitrate of silver freely applied to and around the ulcer, or the continued application of zinc ointment, with tolerably firm bandaging, may bring it into a healthy condition. A more even and constant pressure is secured by strapping the limb with strips of linen spread with soap-plaster, mixed with a little adhesive plaster to fix it. Drawn around the limb, from the side opposite the sore, each strip in succession should partly overlap the preceding one, and the ends be crossed obliquely; thus forming a compact casement, and which should extend two or three inches above and below the sore. This is known as Baynton's method of strapping. The strips should be changed every other day, to remove the discharge; but when the integument has became softened and loosened, so that the sore is beginning to heal, the strapping may be allowed to remain for a week at a time. At length, simple dressing, and the support of a roller-bandage, will complete the cure.

Blistering circumferentially, softens and loosens the integument, and may thus tend to facilitate cicatrization. The actual cautery is recommended by Billroth, to induce purulent inflammation, or to destroy the callous edges entirely. A warm-water bath, according to Zeis's practice, has proved very efficacious in softening the dry, hardened borders of the ulcer. Incisions have been recommended to allow the granulations to contract; and, in most obstinate cases, transplantation of a portion of adjoining healthy integument, sufficient to close in the ulcer, may be tried, with the view of forming a substitute cicatrix. Of these resources, I am decidedly in favour of blistering.

Opium seems to have some special influence in rendering the granulations florid, and promoting the healing of an indolent ulcer. It is therefore advisable to keep the system under this influence by the repeated administration of opium, in small doses. At the same time, the aid of stimulants, tonics, and a general diet should not be overlooked. When an indolent ulcer has healed, the thin and tense cicatrix may be protected and supported with a pad of lint and bandage, worn as long as may be necessary.

The *varicose* ulcer is amenable to the same plan of treatment; but

the varicose state of the veins, as the apparent cause in operation, is an additional and the special object of treatment. An elevated position of the limb to relieve congestion, and an elastic bandage or stocking to equally support the vessels, will prove sufficient for this purpose, in most instances. When the ulcer has healed, it may still be necessary to wear an elastic stocking, as a preventive measure. In more obstinate cases, and with the view of a *permanent* cure, obliteration of the veins must be resorted to. Curved *incisions* may be made, free and deep, on either side of the ulcer-margin, according to the method which Mr. Gay originated, and whereby a twofold principle is fulfilled; the destruction of any circumferential or smaller veins, and relief of the tension of the contracted and indurated skin. Ulcers of from one to twenty years' standing have thus been induced to heal, and with a permanently firm cicatrix. But the larger veins may require obliteration. Of the various means devised—and noticed in connection with Varicose Veins—the safest and most successful, in my experience, is that by *subcutaneous section* of the veins; with the precaution of a *twisted suture*, for compression, on either side, to stop any communication with the circulation. A hare-lip pin is passed underneath the vein, and another at a point about an inch distant. Care must be taken that the vessel be not transfixed, a misadventure easily avoided by dipping the pin, and readily discovered by the escape of a drop or two of venous blood. If the vein be transfixed, the pin should be withdrawn and introduced at another point. A ligature passed round either pin in a figure of eight fashion, will compress the vessel sufficiently to cut off all communication with the venous blood in either direction, and thus isolate the portion of vessel between the pins. Division of the vessel in that situation subcutaneously, as recommended by Mr. Lee, will then more thoroughly insure its obliteration. (See VEINS.) Several such interceptions may be necessary at different points in the course of the saphena vein; in which case the highest pair of pins should be introduced first. The pins must be allowed to remain for about a week or ten days, unless the supervention of ulcerative suppuration should indicate the necessity for withdrawing one or more of the pins at an earlier period. I do not find the tendency to slight ulceration of sufficient importance to require the precaution generally recommended, that of protecting the skin with a piece of bougie before applying the ligature. After this operation, in no case have I seen any perilous consequence, such as phlebitis or pyæmia, but diffuse or erysipelatous inflammation ensued for a while, in one case. In some instances, after the lapse of a year and a half or two years, occlusion of the vein has still been complete, a permanently successful result which has allowed of active exercise with comfort; in other cases, the varicose condition has returned, as the only unfavourable issue; while in yet a few, it has remained on the removal of the pins, and a repetition of the operation has altogether failed.

Venous hæmorrhage, occurring in the course of a varicose ulcer, may be arrested by a compress of lint, secured by a bandage, over the aperture in the vein which has given way; and by elevation of the limb.

(6.) PHAGEDÆNIC ULCER.—Essentially a spreading ulcer, it is characterized by dusky red discoloration and swelling, with perhaps

acute pain around the ulcer; a grayish, glutinous or slimy slough, which exhales a peculiar fœtid odour, occupies the surface of the sore, and the edges, sharp, irregular as if worm-eaten, and undermined, fall away rapidly; thus enlarging and deepening the area of the ulcer. Sloughing may predominate in such ulceration, and hence sloughing and phagedænic ulcers are not uncommonly associated.

Sooner or later, constitutional disorder ensues; irritation rather than inflammatory fever, with great weakness and exhaustion.

Allied as this ulcer is, in its local and constitutional characters, to Hospital gangrene, it would seem that phagedæna arises from an external cause,—contagious matter applied to a sore; the constitutional disorder being secondary and symptomatic, although in its turn affecting the ulcer. On the other hand, habitual deprivation of food, the abuse of stimulants, or living on spirits, and, perhaps, overcrowding, with destitution, seem also to give rise to phagedæna.

Treatment.—To arrest the rapidly spreading ulceration, a free application of strong nitric acid, by means of a glass brush, is most effectual. Followed by poultices, the slough, thus formed, is detached, exposing probably a healthy surface, which has acquired a healing character. Re-application of the acid may be necessary, or the continued application of yeast, charcoal, or chlorinated poultices may be sufficiently stimulant and cleansing; and, at the same time, disinfectant. Opium, administered in small and repeated doses, so as to keep the system under its influence, is most potent in allaying the irritative fever; while the strength of the circulation and healthy nutrition are restored by quinine, the mineral acids, and a generally nourishing diet.

(7.) Hæmorrhagic Ulcer.—Any variety of ulcer may assume this character, but some more particularly—*e.g.*, the irritable, phagedænic, varicose, cancerous, and, perhaps, lupoid ulcers—by the penetration of a blood-vessel; and the scorbutic ulcer, by passive hæmorrhage owing to the blood-condition. Not unfrequently, an ulcer oozes blood about the catamenial period, and especially in women suffering from amenorrhœa; the hæmorrhage then being vicarious menstruation. An ulcer thus acquires a bloody, clotted appearance.

Treatment.—Arising from such various causes, an hæmorrhagic ulcer is a contingency rather than any special variety of ulcer, and should be treated accordingly in connection with whatever ulcer it may be associated, by reference to the particular condition, local or constitutional, which causes the hæmorrhagic character.

(8.) Scorbutic Ulcer.—Although scurvy in itself, observes Mr. Busk, cannot be said to be attended with any peculiar form of ulceration, ulcers or sores of any kind already existing from other causes assume, in consequence of the scorbutic taint, a more or less peculiar character, and when thus modified have usually been termed "scorbutic ulcers." It is the effusion of a semi-plastic fibrous material—the same as that which causes the spongy swelling of the gums, etc.—on the free surface of sores or ulcers, which gives them the peculiar aspect termed scorbutic. Ulcers of this kind are distinguished by their livid colour, and irregular tumid border, around which no trace of cicatrization is evident; whilst the surface of the sore is covered with a spongy, dark-coloured, strongly adherent, fœtid crust, whose removal is attended with free bleeding, and is followed by a rapid reproduction of the same material. This crust, in bad cases, as remarked by Lind, attains to a

"monstrous size," and constitutes what has been named by sailors "bullock's liver."

Treatment.—Regarding a scorbutic ulcer as but a manifestation of the blood-disease—scurvy, the appropriate treatment is that which pertains to this disease; and having regard to its apparent dietetic cause, namely, the deprivation of fresh vegetables, remedial measures will consist, chiefly, in their restoration. Hence the well-known efficacy, preventive and curative, of potatoes and of lemon or lime juice. This dietetic treatment may be aided, medicinally, by the mineral acids and bark; and, as a topical application, a lotion of dilute nitro-muriatic acid has an astringent and cleansing effect on the ulcer.

(9.) Scrofulous or Strumous Ulcers.—Consequent on the ulceration of a scrofulous tubercular swelling, or the opening of a scrofulous abscess, the ulcer is remarkably indolent, yet its characters are unlike those of the ordinary indolent ulcer. Large, pale, flabby granulations, sometimes exuberant, form the surface of the sore, with a thin puriform discharge; the margin is thin, livid, and undermined, sometimes pretending to heal by incrustation of the discharge. The characters and tendency are those of an ordinary œdematous ulcer; but a scrofulous ulcer is even less disposed to heal *soundly*. A scrofulous cicatrix appears drawn, puckered, and incomplete. Small bridges form across the ulcer, underneath which a probe can be passed readily, in and out, here and there. Nature does but "skin and film the ulcerous spot." The co-existence of indolent glandular swellings and abscess, in other parts, will complete the diagnosis.

Scrofulous ulcers are most frequent in the neck, groins, cheeks, scalp; and about the knee, ankle, wrist, and elbow. They are often numerous and clustered.

The immediate cause in operation would appear to be a blood-disease, the nature of which however is unknown. But whatever impairs the nutritive qualities of the blood and its circulation, predisposes to scrofula. Hence deficient or defective food, insufficient ventilation, want of cleanliness and excretion, poor clothing, cold, damp, and even dark localities, with other hygienic conditions of similar import, are the nurseries and nurses of this blood-disease. Individual predisposition, as usual, plays its part; for among a family of children in precisely the same hygienic circumstances, one becomes scrofulous, while the rest remain free.

Treatment.—In addition to the removal of any adverse hygienic condition, iron, bark, and cod-liver oil are calculated to strengthen the circulation and improve nutrition. The digestive organs will also require watchful attention. A stimulating plan of treatment with moderate pressure on the ulcer is appropriate, as for an œdematous ulcer. Thus, nitrate of silver or sulphate of copper, and bandaging, are beneficial as topical appliances; but the more important part of the treatment is constitutional.

The scar of a strumous ulcer is unsightly, and may occasion deformity, either by contraction, or, more commonly, by over-growth, and the formation of bars raised in radiating lines, or networks, or tongues of skin. In such cases, observes Sir James Paget, excision of the scar may be necessary; but in many instances a great portion of the excess of scar can be removed by repeated slight blistering, and with time nearly the whole will level down.

In a superficial scrofulous ulcer on the hands or feet, excessive growth of the *papillæ* at the base or borders of the ulcer, gives a remarkably warty character to the ulcer; which often remaining after cicatrization, leaves a coarse, nodular patch of skin, with opaque, thick cuticle. In this particular resembling a papillary epithelial cancer, the diagnosis of this form of scrofulous ulcer may be determined, by the absence of hardness in the granulations or the base, of a sinuous or upraised border, and of rapidity of progress; and by the presence of more than one, perhaps many such ulcers.

These warty strumous affections may be cured by repeated applications of iodine-paint.

(10.) CANCEROUS ULCER.—Already described in this work, as part of the general history of cancer, the characters of a cancerous ulcer are here alluded to as compared with those of a lupoid ulcer. The scirrhous ulcer is most distinctive. Beginning in the skin and extending down to deeper textures, or commencing subcutaneously—in a cancerous mass, and extending upwards to and involving the skin—the ulcer, formed in either way, presents an irregular cavity, the surface of which is covered with large, hard granulations, discharging a thin, peculiar smelling ichor; the edges are elevated, thick, and everted, with much circumferential induration. The neighbouring lymphatic glands are, or become, indurated, and enlarged. The ravages of this ulcer are unlimited.

Treatment.—See CANCER.

(11.) LUPOID ULCER.—Commencing as a fissure or soft wart, the ulcer formed is an excavated hollow, having, commonly, no granulations, the edges sharp and worm-eaten, with no induration around. The lymphatic glands are unaffected. But this ulcer, also, spreads and spares no texture. It is the true Lupus Exedens, or the disease known also as "noli me tangere," owing to the frightful appearance which is at length exhibited. This disease commences in the earlier half of life, sometimes in childhood, very rarely after middle age; and females are rather more liable to it than males. It is allied to scrofula.

As contrasted with a cancerous ulcer, the differential characters, above stated, were early impressed on my mind by two well-marked cases which I observed when a student at the University College Hospital. The one, an elderly woman—under the care of Mr. Morton —had a large cancerous ulcer of the leg, which presented the appearances I have described; the other, a middle-aged man, an ostler—under the care of Mr. Liston—had a large lupoid ulcer of the cheek, with the appearances already noticed,—namely, opposite to those of a cancerous ulcer.

Treatment.—Various powerful escharotics have been tried with the view of arresting the progress of a lupoid ulcer, and converting it into a healing condition. Caustic potash is very serviceable, as it readily unites with the tissues. Chloride of zinc, mixed with flour and forming a paste by deliquescence, was used in Mr. Liston's case. The intense pain, for a time, which followed its application, would now-a-days be subdued by the continued influence of chloroform. Subsequently, poultices help to bring away the slough. Further extension of the ulcer may be thus arrested, and the cavity evince a tendency, at least, to heal. This favourable change took place in the case alluded to, and I have since met with similar instances. Cicatrization may

ensue. Iron, bark, and cod-liver oil, with other means of improving nutrition, have a decidedly beneficial influence. The disease seldom returns in the cicatrix, but lupoid nodules often re-appear in the immediate neighbourhood. These admit of early excision, as a preferable mode of removal to the more wide-spread destruction resulting from cauterization.

Rodent Ulcer.—Variously named, as Rodent Cancer, Cancroid Ulcer, or Lupus Exedens, the nature of this ulcer is disputed. Dr. C. Warren, of Boston, regards it as a modification of epithelial cancer, but distinguished as the small-celled and non-infiltrating form, and the progress of which is very slow. On the other hand, Mr. Jonathan Hutchinson and Sir James Paget have failed to find in rodent ulcer any of the structural elements of cancer, epithelial or scirrhous. It consists of fibroid tissue, with numerous nucleated exudation-cells. There can be no doubt, however, that the boundary line between these affections, although usually distinct, is not abrupt; that transitional forms occur.

Commencing as a troublesome pimple, situated generally near the nose or inner angle of the eye, this may disappear and return, during a period of some months or years; at length, a small, superficial ulcer forms, having a raised and hardened margin, set in healthy tissue. Progressing slowly, as a fretting ulceration, it spreads to the nose or eyelid, yet sparing the eye until a later period; extending in depth, the ulceration destroys the nose and bones of the face, passing backwards even to the pharynx, and thus forming a hideous chasm, overspread with a greyish pultaceous matter. Similar ulcers are said to have occurred on the breast, and external genitals, but such cases are doubtful. Rodent ulcer rarely appears under forty years of age; and both sexes are about equally liable.

No kind of *treatment* has any curative efficacy. At an early period, the part may be excised; or cauterization, with fuming nitric acid, may have some beneficial influence in temporarily arresting the spread of ulceration. Any portion of loosened bone had better be removed, in order to preserve a cleaner surface, and which lies perhaps beyond the reach of detergent washes. From the carious cavity of deep ulceration I have removed, with forceps, several large portions of loosened bone, blackened, sodden, and fœtid; or entire bones, as the ethmoid, save the cribriform plate, with the vomer, or the maxillary antrum and the palate bone. No hemorrhage attends such procedures.

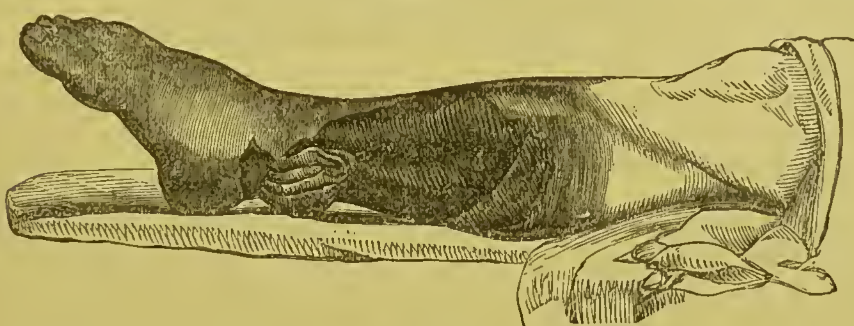
(12.) Syphilitic Ulcer.—Primary, secondary, and tertiary syphilitic ulcers form part of the general pathology of Syphilis.

Mortification.—The transition of ulceration to mortification, as already noticed, will have suggested their mutual relation. As processes, they differ in degree, but are one in kind. The former may be exaggerated into the latter, and this again may subside into that. Ulceration and mortification are convertible by gradations of the same process, disintegration of structure; the one, molecular, as a liquid discharge; the other *en masse*, presenting accumulations of disintegrated matter. Thus, during ulceration, ever and anon some temporary cause may accelerate the process; a larger portion of tissue undergoes disintegration than can pass away as discharge; a portion of such matter then appears as slough, instead of having disappeared imperceptibly—molecule after molecule—in ichorous solution. It is

as if the "flow" of a tidal stream washed up more material than the returning "ebb" can well recover—the line of coast shows the remaining *débris.* Even so, the surface of an ulcer may present a rim of slough, and from time to time, another and another, as the margin of the sore recedes and extends.

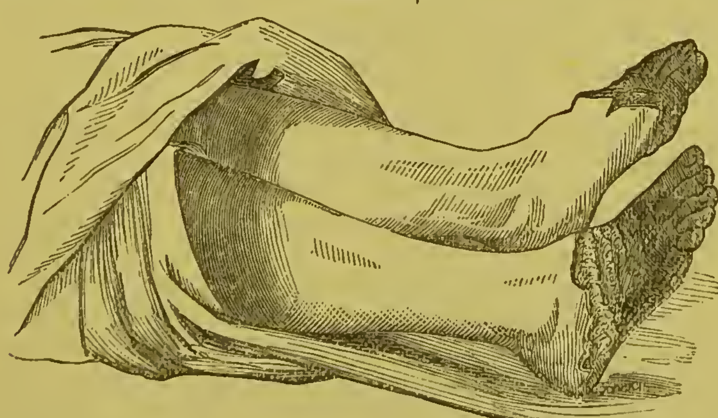
Signs.—Gangrene, or the incipient stage of mortification, exhibits certain characteristic appearances. The skin is livid or has a black hue, shading off to a reddish brown around the dying part. Its consistence is changed; becoming soft, with considerable swelling and pitting on pressure, while the cuticle is raised into vesicles containing a yellowish serum, or phlyctenæ—large bladders, full of bloody serum. The part is, in fact, altogether sodden and succulent, from the infiltration of the constituent cellular texture with serum. This condition is the *humid* gangrene of French authors, the *hot* of German writers, and the *acute* of our own school. (Fig. 76.) Or the part may be

Fig. 76.*



hard, shrunken, and dry. An opposite condition, known as *dry*, *cold*, or *chronic* gangrene. (Fig. 77.) In either state, the sensibility of the part is diminished, and its temperature reduced. The odour of gan-

Fig. 77.†



grene is peculiar and pungent; it becomes fœtid with the evolution of gas by decomposition, which, inflating the cellular texture, much increases the swelling; and owing to the admixture of gas and serum, it then has the additional character of crackling under gentle pressure, or of fluctuation like a collection of pus, if the deeper textures be thus

* Traumatic humid gangrene. (After Liston.)
† Senile dry gangrene. (After Fergusson.)

distended. The part is irrecoverably dead; mortification having advanced to its second and furthest stage—the condition of *sphacelus.* The textures, in this condition also, may be dry and shrunken; as in senile gangrene which has advanced to sphacelus. In either case the part is insensible and cold.

The anatomical condition of sphacelus is somewhat peculiar. Disintegration of the soft textures still prevails; the bones, indeed, may have undergone but little change, otherwise than appearing dry and bloodless, their periosteum being detached; but the articular cartilages and tendons are dull and slightly softened, while all the softer textures have broken down indiscriminately, with one exception. The blood-vessels alone have escaped destruction. Thus, phlegmonous erysipelas may have laid bare several inches of the femoral artery, by sphacelus of the integuments, and yet that vessel remain intact. The blood also —stagnant and coagulated therein, after death—may remain fluid and circulating during life; or, coagulation having taken place, the vessel will be impervious, and perhaps to some distance above the seat of sphacelus. Hence the absence of hæmorrhage during amputation in such cases.

Causes—*External and Internal; and their Operation.*—The pathology of ulceration and mortification being essentially the same, their etiology also is the same.

External causes are of three kinds: physical—as mechanical violence and injury, heat, cold, electricity; chemical decomposing agents; and vital, as animal poisons introduced into any living texture. Either of these external causes may *immediately* kill the part, or kill, if the tissue be vascular, by *inflammation* supervening and terminating, perhaps speedily, in ulceration or in mortification.

(1.) Violence or injury of any kind may give rise to gangrene, which is thence denominated *traumatic.* It is thus distinguished from gangrene arising from any internal, and commonly constitutional disease —*e.g.*, a blood-condition; and which, as a local manifestation of that disease, is thence named *idiopathic* gangrene. This distinction is noticed, more particularly, in connection with contusion and contused wounds.

Of traumatic causes, pressure or contusion, *directly* applied, severely although momentarily, as by a squeeze, kills the part immediately. A finger caught in the hinge of a door may thus be squeezed to death. Pressure, continued, although less severe, excites gangrenous inflammation. In either case, mortification is limited to the part injured. *Indirect* contusion or concussion, as by a fall, produces either gangrene or gangrenous inflammation; and the mortification will be more extensive, although still co-extensive only with the part injured.

Pressure or contusion—applied directly or indirectly—chiefly injures the capillary vessels and smaller arteries; but traumatic gangrene more frequently arises from injury to *larger-sized* blood-vessels. Considerable hæmorrhage takes place, causing gangrene, partly by pressure of the blood extravasated among the textures, partly or principally by cessation of the supply of blood requisite for nutrition. Wounds implicating the larger blood-vessels, compound fracture, and dislocation, especially operate in this way. Gangrene is not necessarily limited to the immediate and apparent seat of injury: it may extend—*e.g.*, up a whole limb, but still only as high as the cause

in operation. Heat, cold, and electricity require no further consideration as *causes* of mortification, than that they operate, either by killing outright, or by inducing gangrenous inflammation; cold, however, not seeming to have the power of killing a part at once. A frost-bitten or frozen portion of the body is not irrecoverably dead.

(2.) Chemical decomposing agents, on the other hand, mostly take effect by killing immediately—decomposing the living tissues with which they come in contact. Such are caustic alkalies, the concentrated mineral acids, and other escharotics.

(3.) Animal poisons introduced into the body, are generally less immediately killing to the part—*i.e.*, they induce gangrenous inflammation. Bites of venomous serpents represent this class.

Internal causes are perversions of the constituent elements of nutrition. Blood of a certain "quality," suitable to each part for its nourishment, and a certain "quantity" of this blood supplied to and circulated through the part; "an appropriate physical and structural condition of the part itself;" and some kind of "nervous influence;" —these are the internal conditions which, when perverted, become internal causes of mortification.

(1.) *Blood-conditions*, by alterations of *quality*, are eminently constitutional causes. Their pathological nature is but little understood; but their local manifestations in gangrene, having characteristic appearances, are well known. Some of these blood-conditions were alluded to, in speaking of the varieties of ulcers as depending on constitutional causes. Other such causes more especially give rise to mortification, in various remarkable forms. Thus are produced carbuncle, boil, and the carbuncle of plague; phlegmonous erysipelas, bloody small-pox, malignant scarlatina; glanders, ergotism, scorbutic sloughing, noma or cancrum oris, the phagedænic and sloughing buboes of syphilis. Other diseases of, or involving, the blood evince a tendency to gangrene; as manifested in uræmia, diabetes mellitus, septicæmia, typhus, and other fevers. Of these gangrenous diseases, those which fall within the province of surgical treatment will be described under the titles referred to. As an example of pure gangrene, from blood-disease, the following may be here noticed:—

Ergotism results in gangrene of the toes or fingers, from eating bread made with the ergot of rye. The symptoms are peculiar; redness and heat, with a tingling itching or crawling sensation in the skin, or sometimes a burning pain, succeeded in a few days by a sensation of cold, then loss of sensibility, and the part becomes black, hard, dry, and withered,—an extreme form of dry gangrene. But a humid and putrid gangrene has been known to occur. The toes are more commonly affected than the fingers; and the gangrene may spread up the foot and leg, even to the thigh, so that both lower extremities, black and dry as charcoal, and shrivelled, have resembled the remains of Egyptian mummies. The fever attending this gangrene is more or less pronounced, and sometimes accompanied with much delirium. Separation of the dead parts may be attended with an excruciating burning pain, followed perhaps by a distressing sensation of cold. An acute and a chronic form of the disease have been recognized; the former being distinguished perhaps by severe general cramps, and death ensuing in from four to eight days; while, in the latter, the patient usually survives, though with the loss of toes or

fingers. According to Duhamel's memoir in the Royal Academy of Sciences, 1748, in 120 cases, not more than four or five recovered. Post-mortem examination shows congestion of the brain, liver, and lungs; the blood also, apparently, has undergone some change, predisposing to hæmorrhage. The cause of this gangrene is a diseased state of the rye-grain,—known as ergot, or spurred rye, when eaten as bread. In this state, the grain is of large size, has a black colour, and horny consistence. But a similar diseased state of wheat may be equally pernicious. The gangrene induced by such food is peculiar to wet seasons and certain localities. First described with accuracy by Dodard, as having occurred in France, 1630, ergotism is uncommon in Germany, Italy, or England.

Mortification arising from any blood-disease spreads without limitation, as to its extent.

(2.) The *quantity* of blood supplied to and circulated through any part depends upon, and is regulated by, the heart's mechanism and action, the state of the blood-vascular system—arteries, veins, and caplliaries—and the physical condition of the blood itself, chiefly in respect of its spissitude and adhesiveness. These conditions are severally, and collectively, more or less causes of mortification.

Of diseases and malformations of the *heart*, their influence in relation to mortification is impressively illustrated by a probably *unique* case, —gangrene of both feet in a boy (like Fig. 77), arising from dilatation of the auriculo-ventricular opening, and of the auricle and ventricle, on the right side of the heart. Double amputation, which I performed by modifications of Hey's and Chopart's operations, was followed by speedy recovery, with sound stumps; but death ensued from cardiac and pulmonary conditions,—pericarditis, capillary bronchitis, and pleurisy.*

Anæmia, with weakness of the heart's action, is a rare cause of gangrene. Both feet, as the parts most distant in the circulation, are specially liable to be affected. This anæmic gangrene occurs sometimes in young chlorotic females; the premonitory symptoms being fatigue, fainting fits, and rigidity of the hands and feet. In one case, Billroth noticed that the tip of the nose first became gangrenous.

(*a.*) *Arteries* are liable to undergo changes of structure, which are particularly worthy of notice surgically.

Ossification or calcareous degeneration of the larger arteries, with fibrous thickening of the smaller ones, is accompanied with a more or less inelastic and contracted state of the vessels, thus leading to coagulation of the blood, in tubes which have become too narrow and rigid for the transmission of that fluid, and in quantity adequate to meet varying demands. This condition represents the changes of structure concerned in producing "senile" gangrene,—a dry form of mortification, commonly affecting the foot, when the arteries of the leg have undergone these changes. Some slight injury, followed by low inflammation, is usually the immediate or exciting cause in such cases. Traumatic gangrenous inflammation is, in fact, engrafted on the state of the arteries, as a predisposing condition. Mortification, commencing generally in a part most distant from the heart, as the ball of the great toe, and thence spreading upwards, gradually assumes the appearance of a black slipper on the foot. (See Fig. 77.)

* "Trans. Clin. Soc.," 1872.

Arteritis—inflammation of an artery—is a far less frequent cause; it acts in a similar manner, and may induce gangrene of the same character, or more dry and horny.

Fibrinous coagulum may form as a thrombus within an artery, either by the deposition of fibrin around a calcareous projection from the interior, or in a sacculated dilatation of the vessel; in either way the clot, gathering more fibrin, advances into the artery, so as at length to entirely plug up the canal. Or, instead of arterial thrombosis, the coagulum may not have formed in the artery where it is found impacted, but have been washed from the left ventricle of the heart and carried thence by the current of blood to that vessel; such a clot being known as an embolus, and an artery thus impacted with clot, as embolism. The gangrene arising from either of these modes of arterial occlusion may be dry or moist, according to the rapidity and completeness of clot formation or impaction.

Rupture of the internal and middle coats of a large artery, by violence, will also induce coagulation; the loose portion folding inward across the stream of blood. Mortification is liable to supervene.

Aneurism is another cause; partly by interrupting the free flow of arterial blood through the aneurismal artery, and partly, by pressure on adjacent veins, obstructing the return of venous blood. Popliteal aneurism will thus induce gangrene, which soon passes into sphacelus.

Wound of a *main* artery acts in two ways. A punctured wound is sometimes an immediate cause, by loss of blood; gangrene taking place in the extremities. Sir B. Brodie mentions the case of a drunken man, who was bled profusely, and both feet became gangrenous in a few hours. A contusion or bruise may lead to sloughing of the vessel, after some days have elapsed; this being attended with hæmorrhage and false aneurism, followed by mortification. Laceration of the vessel may, in like manner, have the same issue. In either case, the integuments may have escaped injury. Simple fracture, and perhaps simple dislocation, will thus lead to mortification, occasionally. Compound fracture and dislocation, far more frequently. *Ligature* of an artery is liable to induce to gangrene, an event which will be considered in the treatment of Aneurism.

It is highly important to observe the *partial extent* to which gangrene spreads, in connection with all these vascular lesions, as contrasted with gangrene arising from any constitutional cause. Unlimited in that case, it is here limited in extent to the *source* of gangrene, and probably restricted to less than that extent, by the enlargement of branches coming from the artery above the seat of injury, which supply a collateral and compensatory circulation of blood. Thus limited is the gangrene arising from the ossification of arteries or senile gangrene; from arteritis; from embolism; from partial rupture of an artery; from aneurism; from wound of an artery, whether punctured, contused, or lacerated; and from ligature. But, then, the limitation connected with *some* of these causes—the point to which gangrene may extend—can scarcely be determined during life. This is the practical ground of distinction between senile gangrene, arising from *ossification* of the arterial vessels, and *traumatic* gangrene; and in favour of the latter, the limitation of which can be more definitely *predicated*. Failing this foreknowledge, the Surgeon must wait the "line of demarcation," drawn by nature.

(*b.*) *Veins* are less liable to become causes of mortification; obstruction to the return of venous blood from any part of the body, having a less important relation in this respect, than obstruction to the supply of arterial blood.

Phlebitis induces coagulation of blood within the vein or veins inflamed, and this obstruction is attended with œdematous swelling of the limb or part below. The swelling becomes tense and persistent, a condition bordering on gangrene. Phlegmasia dolens, in which the iliac and femoral veins, the main venous trunks of the limb, are inflamed, thus perils the leg below.

Fibrous obliteration of a venous trunk is another such cause, once in a way, of tense anasarca.

Phleboliths or vein-stones, not unfrequently formed within various veins, more particularly the iliac, have a similar tendency.

Aneurismal varix and *varicose aneurism*, resulting from a communication between an artery and a companion vein, as from unskilful venesection at the bend of the elbow, is attended with venous engorgement, persistent and increasing, and œdematous swelling of the limb below, threatening gangrene.

Prolonged pressure on a large vein, itself in a healthy state, is an extraneous cause of obstruction to the return of venous blood. Tumours may thus, indirectly, have this effect in relation to mortification. But, usually, pressure produces an entire arrest of the circulation, arterial and venous; as by the application of a tight bandage at the elbow, after venesection, causing gangrene of the hand; the constriction of paraphimosis leads to gangrenous inflammation of the prepuce; and a hernial stricture induces gangrene of the included bowel or omentum. On any exposed part of the body, the influence of prolonged pressure is witnessed in the formation of ulcers, as bed-sores.

The *limitation* of gangrene is no less characteristic of that which arises from obstruction in the course of a large vein, than from obstruction of a main artery; the gangrene, in either case, extending possibly up to, and probably within, that situation.

Thus *both* classes of causes, those pertaining to the arteries and those pertaining to the veins, concur; and differ from any constitutional cause, in relation to gangrene.

But the limitation dependent on *some* venous causes, like that dependent on certain arterial causes, can scarcely be *foreseen*. *Diseased* conditions of veins are more often perplexing in this respect, as compared with any tendency to gangrene of *traumatic* origin from injury to a large vein.

(*c.*) *Capillaries.—Compression* of these vessels is followed by gangrene of the part, if thereby deprived of a due supply of blood.

Inflammation, therefore, with lymph-production, and compression of the capillary vessels, reacts destructively upon the textures. Moreover, inflammatory products, for the most part, are inherently short-lived. And especially during suppuration, the surrounding textures are dying, disintegrating, and being absorbed to make room for the new product—pus; destruction and production here usually keeping pace. Hence the formation of *abscess* necessarily pre-supposes the death and absorption of the textures around; and co-extensively with the formation of pus, which now occupies their place. Sometimes,

they die faster than absorption can remove them, and then their mortification—as sloughing of the soft textures or a sequestrum of dead bone—becomes plainly visible.

Certain conditions *predispose* to gangrenous inflammation. Blood-poisons are constitutional causes of this kind; as in the production of carbuncle and boil, phlegmonous erysipelas, and the other forms of gangrenous inflammation, already mentioned in connection with the constitutional causes of mortification. Intensity of inflammation has a similar tendency. And lastly, the vascularity of the texture affected; a comparatively avascular tissue readily becoming gangrenous, and especially if looseness of texture permit the accumulation of serum, as the cellular tissue in erysipelas; but any texture will be perilled under the pressure of effusion beneath an unyielding investment, as the tendinous expansion of the occipito-frontalis muscle.

(3.) *Physical* and *structural* conditions of the part relative to mortification in general.

Of physical properties; an *unyielding fascia* or aponeurosis, *e.g.*, the fascia lata, predisposes subjacent textures to gangrene, by pressure in the event of any effusion of blood or serum therein. *Looseness* of texture also predisposes to this issue, by favouring an interstitial accumulation of blood or serum. Traumatic gangrene is determined, partly, by these physical conditions impeding the nutrition of the part; although mainly, by the insufficient circulation of blood depriving it of adequate nourishment, and by the damage which the textures have, directly or indirectly, sustained by violence. Structural conditions predispose to mortification; the proportion of blood-vessels having this relation. Both extremes meet. Thus, comparatively *avascular* textures have a tendency to gangrene; *e.g.*, the liability of cellular texture to slough, from any cause. Highly *vascular* textures also have a similar tendency, apparently by favouring the intensity of inflammation and effusion; *e.g.*, the skin as compared with fibrous or tendinous textures, which often resist sloughing long after the integument has disappeared in consequence of an extensive burn.

Predisposition to gangrene from textural conditions is most conspicuous when they are *co-operative* causes. Cellular texture, for example, being comparatively avascular, as well as liable by its looseness to become the seat of interstitial effusions, most readily sloughs.

Causes of Ulceration.—By some variation in the *degree* of any cause of Mortification, this process of mass-disintegration subsides into that of molecular disintegration. Ulceration is mortification by small instalments. Consequently, similar conditions of *texture predispose* thereto. Thus, with regard to vascularity; the less vascular textures are prone to ulcerate, as well as mortify,—*e.g.*, cellular texture and cicatrix tissue; in this respect agreeing with the liability of the highly vascular skin, and mucous membrane, to inflammation and thence to ulceration.

The comparative liability of different textures to ulceration and mortification, is well shown in the natural process by which a dead limb is gradually separated from the living tissues; they detaching themselves from the dead. All, excepting the cellular texture and tendons, are severed by ulceration forming a fissure, which is progressively incisive down to and through the bone. The dead skin, vessels, muscular tissue, and bone are severally detached evenly, by

ulceration; but the cellular texture and tendons die for some distance upwards within the stump, and are separated irregularly, by sloughing.

(4.) *Nervous influence*, of some kind, plays an important part in mortification and ulceration. For example, injury to the spine has been followed within twenty-four hours by mortification of the ankle; and the tendency to ulceration in such a case, or of the cornea in connection with facial paralysis, is equally remarkable.

Considering the whole internal etiology of mortification and ulceration practically, the most important general fact is the *co-operation*, usually, of two or more causes, in either mode of textural death; whereby it is difficult to determine the share due to each internal condition, more especially in conjunction with the operation of external circumstances, such as moisture, temperature, etc.

The Fever of Mortification.—Coincident with mortification, as the local disorganization, the constitutional disorder at once commences. Its phenomena or symptoms are generally more insidious, but not unlike those of Pyæmia, though differing in degree. The patient has a wild apprehensive look, with great restlessness; the features and manner at length become somewhat composed, and the face assumes a pallid hue. In some cases, the tunicæ conjunctivæ, and the skin over the whole body, acquire a peculiar yellow colour. Utter prostration of mind and muscular power gradually supervenes, and a quivering subsultus tendinum steals over the body. The pulse is now very feeble, rapid, and irregular, feeling like a fine rough wire drawn under the finger, and perhaps scarcely to be distinguished from the vibrating *subsultus* of the adjoining tendons. The secretions are soon perverted. The skin, at first hot and dry, is afterwards bathed with a cold, clammy sweat. The urine, fœtid and scanty, may be suppressed. A brown, rough, dry tongue with black sordes encrusting the lips, is accompanied with nausea and a putrid diarrhœa. The powers of organic and of animal life failing, involuntary excito-motions prevail; spasms and convulsions shake the moribund frame, while coma ends in death. Post-mortem examination reveals no appreciable morbid conditions, although Billroth states that, in some cases, putrid abscesses have been found in the lungs.

Or, the mortification ceases to spread. The reddish-brown tint of the skin bordering the dead part, and which has hitherto spread in advance, gets brighter and more circumscribed. A white raised line—the "line of demarcation"—forms in the living skin immediately adjoining the dead; it melts into a groove by ulceration, which extending deeper and deeper, as a fissure, successively passes through tissue after tissue, and at length converging, completely detaches the whole of the dead part. (Fig. 77.) Pending this course of severation from the living organism, adhesive inflammation precedes the line of ulceration, and, corresponding to it in length and depth, seals the blood-vessels; thus effectually excluding any further communication with the dead tissues, and preventing their absorption for the time to come. The typhoid fever immediately begins to subside, and ultimately ceases. In exchange, some degree of "inflammatory fever" accompanies the concurrent process of ulcerative separation and reparative adhesion.

Such is a descriptive outline of the origin, course, and termination, fatal or favourable, of the constitutional disorder proceeding from mortification. Arising with spreading gangrene, it ceases when the

dead part is detached from the living body. Respecting the obvious dependence of this fever on mortification; these two general facts, taken conjointly, seem to warrant the conclusion that absorption of the dead tissues as the connecting link is the immediate cause of the fever. The presence of gas, as decomposition supervenes on sphacelus, is probably a co-operative cause, subsequently, by its direct influence on the nervous system. Absorption of dead matter primarily, nervous sympathy secondarily, and ultimately both together, induce and maintain the typhoid fever which proceeds from mortification.

Treatment of Mortification.

Taking a comprehensive retrospect of the pathology and etiology of (ulceration and) mortification, the Indications of Treatment are four:—

(1.) To remove the cause or causes in operation, and thus arrest the progress of death.

(2.) To remove the dead part—*e.g.*, a slough, a sequestrum, a limb; and the proper time for such surgical interference.

(3.) To solicit the natural separation of the dead part, with reparative closure of the blood-vessels; and then the reparative process of granulation and cicatrization.

(4.) To control the constitutional disorder, consequent on mortification.

(1.) The first indication of Treatment—that of removing the cause or causes of mortification—requires no further explanation than by reference to the causes themselves, whether they be external or internal. Thus, any occasion of pressure, as by a tight bandage, must be removed; or ossification of the arteries in the legs must be managed, by reference to the pathology of this internal cause, as a persistent condition, in senile gangrene.

(2.) Removal of the dead part by operation, and the proper time for such surgical interference.

The earliest opportunity for fulfilling this indication, with due regard to the non-recurrence of gangrene in the part adjoining, may be a highly important question for the surgeon's consideration.

Thus, the removal of a loose slough of soft textures or a sequestrum of bone, cannot admit of any such doubt; for there and then, mortification has become defined.

The *amputation* of a limb will, however, be a question having reference to the *spreading* of gangrene, and the probability of its *recurrence* in the stump.

The consideration which *partly* determines this question is, the constitutional or the local origin of the gangrene. In the former case, spreading *without limitation*, as to its extent, amputation must be postponed *until* the "line of demarcation" has formed; in the latter, limited in its extent to the *source* of gangrene, and probably restricted to within that boundary, by the establishment of a collateral circulation, from above to below, amputation may be performed *prior* to the formation of the line of demarcation. Thus, in traumatic gangrene, from whatever cause,—contused or lacerated wound, compound fracture or dislocation—amputation is determined, not by waiting for the limitation of sloughing, but by the extent of injury as its source.

But in *certain* of these naturally limited gangrenes, the limitation cannot be *foretold*, simply because the exact situation of the causative condition cannot be diagnosed. Of arterial conditions; such are ossification of a main artery or arteries, leading to senile gangrene; arteritis, indefinite in a lesser degree, as to its extent; embolism; and partial rupture of an artery without any external wound. Of venous conditions; such also are fibrous obliteration of a large vein; phleboliths or vein-stones impacted; and phlebitis, indefinite as to its extent. Hence, in all these cases, arterial and venous—the treatment appropriate for the particular causative condition having failed—amputation must be deferred until *such time* as nature has indicated, by the formation of the line of demarcation, that limitation which cannot be foreseen. The venous conditions referred to seldom, if ever, necessitate amputation.

On the other hand, the line of demarcation can be foretold, in other cases of *definitely* local origin. Such are aneurisms, spontaneous and traumatic, and wounds of a main artery; aneurismal varix, and varicose aneurism; and any occasion of prolonged pressure on a large vein. Hence in all *these* cases—arterial or venous—the treatment appropriate for the particular causative condition having failed, amputation may be resorted to before the formation of the line of demarcation has indicated the actual extent to which the gangrene will spread.

Generally speaking, the rule for amputation may be thus stated, in all cases of local origin; *idiopathic* gangrene, however caused, suggests the postponement of amputation *until* the limitation of gangrene is declared by Nature; whereas *traumatic* gangrene, however caused, suggests amputation more immediately, this anticipation of Nature by Surgical Art then being justifiable. Two exceptions are urged by Erichsen—namely, gangrene from frostbite, and that from severe burns. In these injuries, he considers it better to wait for the formation of the line of separation, and then to fashion the stump through or just above it, as the circumstances of the case require.

In *Spreading* traumatic gangrene, the question of amputation is to be determined rather by the consideration that a constitutional cause is in operation. Operative interference, therefore, should be deferred, pending the formation of the natural line of demarcation,—as was directed by Sharp and Pott. The contrary rule is, however, maintained by Larrey, and some other modern surgeons of large experience; that in this condition, if life be in danger, amputation should be performed, although gangrene may yet be spreading.

(3.) Solicitation of the natural separation of the dead part, with reparative closure of the blood-vessels; and the healing process of granulation and cicatrization.

Constitutional gangrene, or gangrene arising from *local* conditions the exact situation of which cannot be diagnosed, may, in either case, have compelled the delay of amputation until the line of demarcation takes place; but Surgical Art should solicit this limitation, and thus also, if possible, restrict the extent to which the gangrene might otherwise have spread. By maintaining the *temperature* of the part not yet mortified, the local circulation may become diffused sufficiently to sustain its vitality; whereby the line of demarcation between the living and the dead portions will be declared. Hence, the preventive value of cotton wadding, with which material the limb

should be deeply enveloped. This padding need not be reapplied for some days; the gangrenous part being covered with lint soaked in a solution of permanganate of potash (Condy's fluid), a chlorinated, carbolic, or other antiseptic lotion. Concentrated solutions of carbolic acid, *e.g.*, ʒ ii to 1lb of olive oil, are apt to induce symptoms of poisoning, indicated by olive-green urine. (Billroth.) A poultice of powdered charcoal answers the double purpose of an antiseptic and moist warm dressing.

In *senile gangrene*, the line of demarcation having formed, and separation of the dead part slowly taking place, reparative closure of the blood-vessels will be promoted by a light poultice or epithem of moist spongiopiline, to encourage adhesive inflammation. When the soft textures are thus safely detached, the bone may be sawn through, and the otherwise natural amputation completed by this amount of surgical interference.

Granulation and cicatrization supervene as in the healing of a healthy ulcer, although perhaps more slowly than usual. Simple water dressing, or some gently stimulating lotion, will therefore generally prove sufficient in the way of topical treatment. Balsam of Peru, pure or diluted, with an equal part of yolk of egg, is highly recommended as an application in these cases. Remembering the persistent cause of gangrene, namely, ossification of the arteries, exposure to cold must ever be avoided, and the circulation in the legs cherished by the patient wearing thick woollen socks, flannel drawers, and other such warm clothing.

(4.) *Constitutional Treatment.*—Prior to closure of the vessels, the constitutional disorder consequent on gangrene—the *typhoidal* fever—requires supporting measures; an easily assimilated diet, comprising proportionately more animal food, malt liquor, and alcoholic stimulants, will prove most beneficial. Of medicinal stimulants and tonics; the sesquicarbonate of ammonia and chlorate of potash, with cinchona bark or cascarilla, form a combination which is, I think, more lauded in the books, than suggested by pathology or sanctioned by experience. Opium is, generally, a remedy of great value, apparently by subduing the pain and nervous excitement; and by promoting the capillary circulation, thus aiding the process of separation. It should be administered in small but repeated doses, to the amount of two to four grains in the twenty-four hours, and increased as the system is brought under its influence; but opium is contra-indicated or must be discontinued, whenever it disturbs the digestive organs or occasions headache. The hypodermic injection of morphia may, however, not be obnoxious.

Inflammatory fever, in some degree, accompanies occlusion of the vessels during the separation of the gangrenous part; opium may, therefore, still be continued to suppress nervous excitement and the heart's action, while it perhaps sustains adhesive inflammation. The stimulant and tonic plan of treatment should be moderated during this period, and resumed during convalescence.

DISEASES OF THE BLOOD.

CHAPTER V.

SCROFULA.

By the term *Blood-disease*, I mean a disease in which some alteration of the blood is the primary affection, as from a poisoned wound; or is the central condition, although the blood-forming organs, and all the textures, in the processes of assimilation, primary and secondary, and thus the whole body may be engaged in the disease. The latter will be considered first, as representing blood-diseases of a *constitutional* character, essentially. Their affinities and differences are of great practical importance.

Scrofula should be distinguished from Tuberculosis; for these diseases do not appear to be identical, as some pathologists have maintained, and even still allege. I endorse the view held by Sir James Paget, that *this* is their relation—"the scrofulous constitution implies a peculiar liability to the tuberculous diseases, and that they often co-exist. But their differences are evident, in that many instances of scrofula (in the ordinary meaning of the word) exist with intense and long-continued disease, but without tuberculous deposit; that as many instances of tuberculous disease may be found without any of the non-tuberculous affections of scrofula; that, as Mr. Simon has proved, while diseases of 'defective power' may be experimentally produced in animals by insufficient nutriment and other debilitating influences, tuberculous diseases are hardly artificially producible; and that nearly all other diseases may co-exist with the scrofulous, but some are nearly incompatible with the tuberculous."

General Symptoms.—Scrofula exhibits itself locally by "mal-nutrition and chronic inflammation." This inflammation is scarcely expressed by pain or heat, or redness, but rather by swelling, more or less considerable and doughy, slowly enlarging, and tending to suppuration; yet scrofulous suppuration is unwilling, so to speak, and the pus a mixture of curd and serum. Should a scrofulous abscess point, the skin thins, but gradually, and assumes a purplish tint; an irregular rent follows after some time, and the flaky matter rolls out. Perhaps this aperture gets blocked up and imperfectly closed; the matter re-accumulating, again to be discharged, and so on from time to time. Or the aperture may remain free, with puffy everted edges, of a purplish colour, and the discharge continue—now thick, now thin.

The *scrofulous ulcer*, which eventually results, is equally indolent. It persists, with a thin, livid, undermined margin, large, pale, flabby

granulations and a glecty discharge; although sometimes pretending to heal, by this discharge crusting over its surface. Should cicatrization ensue, the scrofulous cicatrix appears drawn, puckered, and incomplete. Small bridges form across the ulcer, underneath which a probe can be passed readily, in and out, here and there. Nature does but "skin and film the ulcerous spot."

Special Forms.—Scrofula is essentially a "pervading" disease. It blossoms and bears fruit chiefly in the absorbent glands, in the skin and cellular texture, mucous membranes, bones and joints, eyes, salivary glands, tonsils, ears, breasts, and in the testicles. Then, again, in some cases, various parts are simultaneously affected, in others consecutively; the scrofulous affection "migrating" from one texture or part to another texture or part. But their order of priority cannot be stated with accuracy. In some textures, the scrofulous affection is more *pronounced* than in others.

Absorbent glands, so called, appear to invite the deposit of scrofulous matter. At first soft and fleshy, these glands enlarge and harden; portions of each gland are observed to have altogether lost their flesh colour, and acquired a degree of transparency, and a texture approaching to that of cartilage. At length, a soft, white, or yellowish, curd-like substance is deposited. Glandular tumours, thus formed about the neck and groin, sometimes attain an enormous size; in the latter situation, being perhaps half as large as the head of a new-born child. An enlarged scrofulous gland is not necessarily impervious—at least, mercury can be injected in many instances. Scrofulous glands are remarkably indolent, but eventually they soften and discharge the peculiar pus—flaky and ichorous, perhaps cretaceous matter; or they remain as soft and spongy tumours, beneath a thin, silky cuticle, which frequently breaks and oozes; or they waste, and are at length represented only by a few bands of condensed cellular tissue attached to the cicatrized integument.

Absorbent *vessels* are said to be rarely the receptacles of scrofulous matter, but there are such instances on record.

Chronic enlargement with suppuration of the lymphatic glands is one of the earliest and most characteristic manifestations of scrofula. In childhood, therefore, these glands may be found as just described, in various stages of scrofulous inflammation and suppuration. Yet this is a rare event in children under two years of age. Cullen mentions a case in which the disease broke out at the very early period of three months. Taking the other extreme, Thomson found the mesenteric glands affected with scrofulous inflammation in persons of *very* advanced age.

In various parts, also, of the body, the lymphatic glands may become scrofulous. Those in the neck—*glandulæ concatenatæ*—are perhaps most frequently affected. This enlargement of the cervical glands is apt to arise from slight and transitory injuries and affections of the hairy scalp, ears, eyes, nose, and more particularly from slight and temporary affections of the teeth, gums, and other parts within the mouth. Decay of the first teeth is often the immediate cause of scrofulous glandular swellings in the neck, but their eruption, seldom or never. The axillary and crural glands are less frequently affected than those of the neck. The mesenteric glands are very liable to undergo scrofulous inflammation, constituting that formidable disease

tabes mesenterica, by arresting the absorption and passage of chyle through these glands, and thus inevitably depriving the whole body of its nutriment. A tumid abdomen, with progressive emaciation, begets suspicion of this disease; while detection of the mesenteric mass, by palpation and percussion, will go far towards confirming our diagnosis. But we look for the *concurrence* of some other expressions of the scrofulous diathesis. Age, also, should be taken into account; although, in this respect, Thomson found the mesenteric glands affected in children two years old, in persons between twenty and thirty, and in those who had passed their sixtieth year.

The *cellular texture* is peculiarly liable to exhibit scrofulous swellings, bordering on suppuration or actual collections of matter.

In the subcutaneous cellular tissue, small *nodules* are apt to form closely resembling scrofulous glands in appearance. They often appear very suddenly; and from the absence of pain and discoloration, they may exist a long time without being perceived. They are usually of an oval figure, and seem to be produced by the effusion of a fluid into the interstices of the cellular texture; they are very variable in their size, being one day more prominent and tense, and the next more flaccid. Subcutaneous *abscesses* may form, and are usually numerous. When an absorbent gland suppurates and bursts, a fistulous sore is the result; but abscess in the subcutaneous cellular texture commonly terminates in an open scrofulous ulcer.

In the *sheaths of muscles*, large chronic abscesses sometimes gather insidiously, containing the pus which characterizes scrofulous suppuration.

The *skin* is more than liable—it is prone—to scrofulous eruptions and ulceration. Its wrinkled seams and puckered scars are familiar to common observation. And these vestiges are not unfrequently " symmetrically " disposed on either side of the body. An instance of remarkably symmetrical scrofulous scars on the neck and fore part of the chest, occurred in a patient of mine at the Royal Free Hospital. In the middle line, a vertical scar extended downwards to the sterno-clavicular articulation, terminating in a kind of root, and upwards to the os hyoides. From thence a branch scar passed upwards and backwards to the angle of the jaw, on either side; and from this again, on either side, another seam extended upwards to the mastoid process, and downwards on the sterno-mastoid muscle. Either axilla was the seat of a horizontal seam, which discharged a small quantity of scrofulous matter. According to the special experience of Erasmus Wilson, cutaneous scrofula is presented in two conditions—that of *tubercles*, and that of *ulcers*. Scrofulous tubercles are small, purplish or livid, indolent tumours. They soften internally and discharge an imperfect pus, remain open or fistulous for a long time, and on disappearing, frequently leave hard knots in the skin. They appear on the neck and face, and near ulcers resulting from inflammation of the absorbent glands. When such tubercles have partially discharged their contents, a crust of inspissated matter forms, which being rubbed off occasionally, exhibits an open sore, with an ichorous discharge, and no disposition to heal. Eventually an ugly cicatrix or scar marks the site of these sores. Usually but one scrofulous tubercle arises; sometimes a group of three or four close together, which may have a circular arrangement, enclosing an area of thin, shining, livid or purplish skin. Rings of

this kind occur chiefly on the back of the hands and feet. They are very intractable.

The characters of the scrofulous ulcer need not be repeated. An irregular, livid, and puckered scar is its remnant. Such cicatrices are seen mostly in the neck, near enlarged glands, and in the neighbourhood of joints.

Inflammation of the *matrix* of one or other of the *nails* is not uncommon, more particularly in young persons having the scrofulous diathesis. Scrofulo-derma ungueale, so named, begins by inflammation of the skin immediately round the edges of the nail about to be affected; then follows considerable swelling, with vivid redness of the end of the finger, extending even to the bone, and presenting the appearance of a clubbed finger. The nail is shed, disclosing an angry raw surface, upon which, from time to time, there reappears a rugged, ill-formed, and imperfect nail. Fungous granulations and unhealthy pus continue for perhaps many months.

Other *cutaneous* manifestations of scrofula are noticed by some writers. Porrigo favosa, larvalis, and furfurans; eczema impetiginodes and rubrum, in their chronic forms; and that variety of lupus which appears as small, red, button-like, indolent tubercles, chiefly on the lips and nose, occasionally on the genitals. These tubercles excoriate and run into eroding ulcers, with pale, shining, spongy granulations and encrusted margins; or perhaps this work of destruction is concealed by a thick incrustation, which every now and then drops off, exposing its subjacent ravages.

The *osseous system* and the *joints* seem to invite scrofulous inflammation—in this respect somewhat contrasting with the indisposition evinced by these structures towards the syphilitic poison, unless reinforced by mercury. The bones and joints, then, are more conspicuous in the history of scrofulous manifestations. In the *extremities* of long bones, or in the bones of the carpus and tarsus, their cancellated portion is specially liable to undergo scrofulous caries. Sometimes this species of mal-nutrition runs its course within the *shaft* of a long bone, but generally speaking, as I have said, in the neighbourhood of joints. The latter are secondarily invaded, caries so placed then being denominated "scrofulous disease of the joints."

In the career of scrofula, *mucous membranes* are not exempt from harm, particularly if its blood-associate, tuberculosis, be considered an ally. The eyes, ears, nose, upper lip, tongue, tonsils, salivary glands, and larynx, severally exhibit scrofulous inflammation; yet this is not altogether limited to the mucous membrane in connection with these parts.

Scrofulous ophthalmia is a variety of conjunctivitis, characterized by great intolerance of light; so that the child (for this affection occurs mostly in young subjects) seeks a dark room, or buries its head in the bed-clothes, and screws its brows together with screaming agony on any attempt being made to examine the eyeball. From habitually endeavouring to exclude the light, the corrugator and orbicularis muscles become hypertrophied, eventually giving a remarkable heaviness of expression. When the eyelids are separated, a copious flow of tears trickles down the cheeks, excoriating the face. The eyeball is now involuntarily upturned to avoid the light, a patchy redness is observable on the conjunctiva, and vesicles or pustules are seen here

and there at the margin or on the surface of the cornea. These pustules burst and expose small ulcers. Frequently an interstitial deposit overshadows the whole cornea, which thus becomes thickened and opaque (pannus), projecting also, so that the eyelids cannot be closed. This is one destructive sequel, and should ulceration of the cornea not terminate comparatively favourably, in specks of opacity, perforation of the anterior chamber will be inevitable, the aqueous humour is discharged with prolapsus of the iris, and the eye collapses.

Fretting ulceration of the Meibomian glands, attacking the margin more especially of the eyelids, and known as ophthalmia tarsi, is a frequent concomitant of scrofulous ophthalmia; or this diseased condition extends to the iris, giving rise to scrofulous iritis. But there is nothing peculiar about this variety of iritis, taken *per se;* and indeed it is only as one of a *series* of local manifestations that we venture to designate it "scrofulous" iritis, and refer the whole series to one and the same constitutional cause in operation.

The organs of hearing do not escape. Chronic suppuration perforates the tympanum; the ossicula crumble, loosen, and are washed out by the discharge.

The nose assuredly enjoys no immunity. Habitual swelling, ulceration, and fœtid discharge from the pituitary membrane—ozæna—may or may not be accompanied with caries and discharge of portions of the spongy bones.

The upper lip is commonly tumid, protuberant, and chapped. Fissures also and ulcerated spots are seen on the tongue. Nodules, moreover, superficially imbedded in the substance of this organ are said to arise in most instances, and to present the following characters. They vary in size from a small shot to that of a horse-bean; are painless, unless subjected to firm pressure, which occasions a pricking sensation. The superimposed mucous membrane reddens, soon breaks in the centre, and forms an ulcer, which spreads and destroys by sloughing erosion; accompanied with much pain, profuse salivation, furred tongue, and fœtid breath. If cicatrization ensue, hardness still remains; fresh nodules also form in other parts of the tongue.

Chronic and considerable enlargement of the tonsils, with perhaps indolent ulceration, is another outbreak of the scrofulous diathesis; so likewise is swelling of the sub-lingual, sub-maxillary, and occasionally the parotid salivary glands; but these affections alike owe their significance to the invariable co-existence of other local diseases of more unequivocally scrofulous origin.

Chronic laryngitis may be due to this constitutional cause. The vocal cords become thickened; the voice therefore is hoarse or squeaking, and the breathing embarrassed; a tickling cough from time to time ejects a slimy, not frothy, expectoration, streaked with blood perhaps; or the sputa are muco-purulent. In either case the breathing is relieved by this expectoration; but eventually ulceration of the rima glottidis renders its closure imperfect, the act of coughing incomplete, and expectoration therefore difficult; so that the respiration is yet more oppressed. Should ulceration of the epiglottis supervene, there will be considerable difficulty of deglutition.

A certain *mammary tumour* was first described by Sir A. Cooper. In young women, says this author, who have enlargement of the cervical glands, I have sometimes, though rarely, seen tumours of a

scrofulous nature form in their bosoms, confined in most cases to a single tumour in one breast; but in one case two existed in one breast, and one in the other. They are entirely unattended with pain, are distinctly circumscribed, are very smooth on their surfaces, and scarcely tender to pressure. They are very indolent, but vary with the state of the constitution, diminishing as it improves, and increasing as the general health is deteriorating. They can only be distinguished from simple chronic inflammation of the breast, by the absence of tenderness, and by the existence of other diseases of a similar kind in the absorbent glands of other parts of the body. They produce no dangerous effects, and do not degenerate into malignancy.

Lastly, a peculiar enlargement of the testicle, or rather, of the *epididymis*, is worthy of special notice among the local manifestations of scrofula; and it particularly exhibits the usual characters of stealthiness and slow development. A small nodule, consisting of yellow friable matter deposited within the tubules or ducts, appears generally at one end of the epididymis; little pain or tenderness attends this structural change, and it may progress without complaint. Another and another such nodule forms on the surface of the testis, but generally connected with the epididymis, which becomes beset with three or four small tumours. Thus the testicle itself feels enlarged and irregular at an early stage of this disease.

It has been stated by Mr. Curling, that scrofulous matter is also deposited within the body of the testis, in the form of pearly or greyish bodies, of the shape and size of millet-seeds—*i.e.*, grey granular tubercles, which I suppose this description denotes. That these tubercles have a linear arrangement, like strung beads, less abundant and less regular in the anterior part of the organ than towards the rete-testis, where they are closely set, and sometimes confluent; and that they undergo transformation into a yellow friable cheesy substance, which at a later period softens, and is often broken up into a curdy purulent fluid, the gland-structure being absorbed to give place to this tuberculous matter. But, if tubercles are deposited within the testicle itself, this structural change signifies little in reference to the diagnosis of this disease, for the testis is often masked by small local effusions of fluid in the tunica vaginalis, the surfaces of which are partially adherent.

Now, the epididymis may remain nodose for many months; the nodules quiescent, or enlarging very slowly, and becoming painful. At length one declares itself more than the rest, attaches itself to the skin, which then assumes a purplish discolouration, ulcerates, and discharges a curdy purulent matter—the substance of the nodule. Other nodules undergo successively this process of disintegration, softening, and evacuation; but, unlike healthy abscesses, they do not heal. Fistulous openings obstinately continue to exude a mixed discharge—now curdy, now serous, now seminal; and in this advanced stage of the disease, destruction of more or less of the gland-substance is inevitable. According to Sir B. Brodie's observations, occasionally one testis is completely disorganized; more frequently the organ is only partially destroyed, and a considerable portion of the glandular structure remains unimpaired. Sometimes the disease is confined to one testicle; sometimes both are similarly involved.

By this process of disorganization and protracted discharge the

testicle is drilled and worm-eaten, as it were; so that eventually the organ collapses and shrivels up, a fragment only of its former self. There is seldom, therefore, any protrusion of gland-substance through the fistulous scrotum; on the contrary, in a favourable case the apertures gradually become inverted and depressed, leaving, after the lapse of time, a puckered cicatrix, adherent to the remaining portion of the gland, as a lasting record of all this mischief.

Blood-pathology.—In concluding this summary of many local diseases, which, possessing the same general characters, are fairly associated under the name of Scrofula, it is impossible to overlook at least two general facts that indicate their blood-origin. These diseases are perversions of nutrition in "many" textures and organs simultaneously; they "migrate" from one locality to another, and they are occasionally symmetrical. So, therefore, scrofula is, properly speaking, a blood-disease, and the diseases alluded to are but local manifestations of a constitutional cause in operation.

Nothing definite is known respecting the composition of the blood in scrofula. The blood is said to be rich in its amount of fibrin, but thin, of inferior plastic quality, and poor in its proportion of red corpuscles; such is the result of analysis by Andral and Gavarret: that the solids of the serum are increased, and the blood-globules diminished, was the result of Dr. M. Glover's analyses; and so on I might enumerate the conclusions of many other distinguished chemists.

Causes.—*Temperament.*—Certain bodily organizations evince a tendency to scrofula, and beget a suspicion that it will declare itself in some way, sooner or later. Individuals thus constituted are ever verging on this morbid condition, with threatenings of its outbreak here or there; but it must be confessed that no one temperament alone possesses the scrofulous character. It is the tendency of those whose circulation is habitually weak—are *leucophlegmatic*—who have flabby muscles, a dull muddy complexion, large heads, pigeon breasts, tumid bellies, and large joints; but then the strumous tendency is manifested in those persons also who, with a more active circulation, are rather of the *sanguine* temperament, have firmer muscles, a clear, transparent, ruddy complexion, which readily assumes a purple or livid hue by exposure to cold. The circulation, although active, is susceptible. Chilblains, therefore, not uncommonly occur in children of this temperament; while their yellow or reddish hair, large lustrous blue eyes, crimson-patched cheeks, and pouting upper lip, are associated with that lively, impulsive, affectionate, and precocious disposition which so often raises hopeful expectations never to be realized.

In contrast, however, with this organization and with these mental endowments, the same strumous tendency may be evinced in the highest degree by those who, without any marked character of circulation, are habitually subject to biliousness. In such persons the liver seems to be their weak point. Sluggish, yet enduring power is theirs also; and hair approaching black in colour, a dark olive or yellowish complexion, and dry skin, are aptly associated with a gloomy, often resolute, and reflective disposition. Theirs is the *melancholic* temperament. These are the chief signs of the scrofulous *diathesis*, although it *may* appear also in persons of the *nervous* temperament; and, indeed, the same tendency can be induced in those who are congenitally most indisposed to it when subjected to circumstances favourable to its development.

Hygienic Conditions.—Whatever impairs the nutritive qualities of the blood and its circulation may produce scrofula; therefore, deficient or defective food, indoor life, insufficient ventilation, want of cleanliness and excretion, poor clothing, cold, damp, and even dark localities, with other *circumstances* of similar character, are the nurseries and nurses of this blood-disease. At the same time, *individual* predisposition, as usual, plays its part; for among a family of children in precisely the same hygienic circumstances, one becomes scrofulous, while the rest escape.

Treatment.—*Preventive* measures are far more efficacious than remedial treatment. They consist in the anticipation or timely removal of the predisposing hygienic conditions just adverted to; any inborn predisposition by temperament being beyond prevention. Due attention to food is primarily important. In the absence of more precise knowledge respecting the blood-condition in scrofula, it is impossible to direct and regulate the diet chemically. Experience, however, suggests a light nutritive diet, and not to overload the stomach by a heavy meal. Stimulants may be necessary to assist digestion, but they should be indulged in sparingly. The pampered scrofulous child of affluent parents is as badly off as the ill-fed child of the poorest. The bowels, which are very apt to be costive, or at least irregular in their action, will require the assistance of gentle aperients, such as rhubarb or the confection of senna. Not less important is daily exercise in pure air, and ablution not only to cleanse the skin, but to invigorate the circulation and promote excretion. Hence, sea-bathing may prove very beneficial. Friction with the horse-hair gloves and belt, or a rough towel, and warm clothing, with flannel next the skin, are likewise salutary. But, a warm, dry, light locality for habitation, in a well-ventilated and well-drained dwelling, constitute the hygienic surroundings which are most preventive of scrofula. The latter, especially, is a hard prescription for the poor to carry out. Among, however, the many blessings bestowed on them in this vast metropolis, by the imperishable philanthropy of Mr. George Peabody, a yearly decreasing predisposition to scrofula will perhaps be the greatest boon.

Curative treatment implies the same continued attention to the removal of any causes provocative of this disease. The hygienic conditions of diet, exercise, air, ablution for cleanliness and invigoration, clothing, and climatic influence, are still of paramount importance. But certain medicinal agents, principally iron, iodide of potassium, bark, and cod-liver oil, have an acknowledged therapeutic value.

Iron may be given in the form of vinum ferri, the ammonio-citrate, the citrate or the sulphate of iron; the latter of which preparations I prefer, as it improves the blood more effectually. This is denoted by a notable arrest or diminution of any scrofulous deposit in the glands or other parts of the body.

Iodide of potassium has a beneficial influence on scrofulous deposit, apparently by promoting its absorption; but I must confess that this influence seems to me overrated. Iodide of iron is unquestionably remedial, but this is probably due to the iron rather than the iodine. Perhaps, therefore, the therapeutic value of iodide of potassium in scrofula, may be attributed to the latter ingredient; an explanation in harmony with the generally accredited efficacy of other preparations of potash in this disease.

Cod-liver oil must be regarded rather as a food than a medicine; by supplying the diminished amount of fat in the blood, relative to the fibrin. It certainly has a most marked influence on scrofulous malnutrition. Cinchona bark, whether in the form of decoction or tincture, or quinine, is highly serviceable as a tonic in strengthening the circulation, and thence indirectly improving nutrition and all other functions. But it has no special influence on scrofula, and must be regarded as an adjunct to other medicinal measures. I am thus accustomed to prescribe the sulphate of iron in doses of three to five grains, with one or two grains of the disulphate of quinine, three times a day; coupled with a teaspoonful of cod-liver oil.

Local treatment has some effect on the *chronic enlargement of glands*, and of other parts, arising from scrofulous deposit. Applications of the compound tincture of iodine, or the stronger iodine-paint, may be advantageously aided in their stimulant operation by the pressure of strapping with soap plaster, or bandaging. Usually, however, these glandular enlargements will not subside, at least under topical treatment. When *abscess* forms, and discharges subsequently as an *ulcer*, these results must be treated accordingly. Much has been said about the virtues of caustic potash and other barbarous modes of apparently punishing a scrofulous abscess or ulcer; but there need be nothing peculiar in their local treatment, and it should ever be remembered that constitutional treatment can alone have any curative efficacy in scrofula.

Operations for scrofulous conditions of the bones, joints, or other parts, should be determined by the same consideration. Constitutional treatment will often succeed in averting the necessity for excision or amputation; a highly important consideration, since any local form of a constitutional disease is always an unfavourable condition for operation, and the removal of the part affected can in no way cure that disease as the primary cause. Hence, also, the postponement of such operation may not unfrequently be justifiable; and until the local condition becomes more defined, or its progressive extension renders operative interference imperative, whether with regard to the part affected or its reactive influence on the general health.

Scurvy and Purpura.

General Symptoms.—Scurvy and Purpura are alike manifested by hæmorrhages into many textures, occurring at the same time or in succession; and it will be readily imagined that these hæmorrhages take place with greater facility in some textures than in others. Into *cellular* tissue, for example, blood is very apt to escape. Such spontaneous hæmorrhages result from alterations which the blood itself has undergone.

Scurvy.—*Symptoms.*—The symptoms of scurvy may be well illustrated by a supposed case. A sallow and dejected-looking man, whose strength has been gradually failing, becomes the subject of hæmorrhages of a peculiar kind. The gums are turgid, spongy, and rotten; they ooze blood on the slightest pressure; the teeth loosen in their sockets and drop out. This fungous condition of the gums ceases abruptly at the reflexion of the mucous membrane to the lips, which are extremely pale; so also are the tongue, fauces, and inside of the cheeks. In some rare instances, however, the lividity extends nearly

all over the hard palate. Red or livid spots are found on various parts of the body, principally on the legs, together with bruised-looking patches, of a yellowish-green colour, swollen and as hard as brawn.

Extensive effusions of *fibrin* rather than pure blood, forming very hard, broad, and painful swellings, are found imbedded in the deep cellular texture and between muscles. Over these fibrinous mats, the skin sometimes retains its natural colour, but usually appears bruised, is always thickened and brawny, and adherent to the subjacent textures. Swellings such as these occur particularly in the thighs and legs, but most commonly in the hams, occasioning stiffness and contraction of the knee-joint. Nodes also arise from this effusion taking place between the bones and their periosteal investment; the tight swellings formed thereby giving great pain upon the slightest motion, even by turning in bed. None of these effusions, whether of fibrin or blood, ever suppurate; nor do the nodes just mentioned, however large their size, ever cause the bone to exfoliate.

The dark livid or purple colour of scurvy overshadows any skin-eruption, wound, or ulcer, which may chancé to be present during this disease. A dark grumous coagulum juts out from the surface of an ulcer; and this—which, owing to its appearance, has been named by sailors *bullock's liver*—often attains an incredible size in the course of a single night. To conclude the catalogue of hæmorrhagic lesions, repeated issues of blood from the nose are common, blood may be coughed up or vomited, lost by the bowels, and perhaps passed with the urine.

Scurvy is apt to prove fatal suddenly, from exhaustion. This remarkable feature in its career, with others of instructive moment, were exemplified in an equally remarkable manner during Lord Anson's expedition, 1740–44. The narrative states:—"Many of our people, though confined to their hammocks, ate and drank heartily, were cheerful, and talked with much seeming vigour and in a loud, strong tone of voice; yet, on their being the least moved, though it was only from one part of the ship to another, and that in their hammocks, they immediately expired; others, who confided in their seeming strength, and resolved to get out of their hammocks, died before they could reach the deck. It was no uncommon thing for those who could do some kind of duty and walk the deck, to drop down dead in an instant, on any endeavour to act with their utmost vigour; many of our people having thus perished during the course of this voyage."

Purpura.—Similar *Symptoms* characterize Purpura, but there is not the same marked dejection and feebleness, nor are the gums always fungous. Extravasation of blood occurs in the form of small, round, purple spots, rather than parti-coloured blotches. These spots of blood are scattered in almost every texture. According to Sir Thomas Watson's experience, they are not peculiar to the skin, nor to the subcutaneous tissues, but occur occasionally upon all the internal surfaces also, and within the substance of the viscera. For example, on the mucous membrane of the mouth, throat, stomach, and intestines; on the pleuræ and pericardium, in the chest; on the peritoneal investment of the abdominal organs; in the substance of the muscles; and even upon the membranes of the brain, and in the sheaths of the larger nerves; and they may be accompanied with large extravasations of blood in most of the vital organs of the body. Such lesions are neces-

sarily perilous. Bateman states that he witnessed three instances in which persons were carried off, while affected with purpura, by hæmorrhage into the lungs. Watson saw two post-mortem examinations, in both of which a considerable quantity of blood was found spread over the surface of the brain, between its membranes; and in one of these cases blood was extravasated also into the cerebral substance, with extensive laceration.

Blood-pathology.—Scurvy and Purpura are *plainly* blood-diseases. The *blood* itself spontaneously exudes, and appears as a bruise, yet without any bruising force having been applied. This hæmorrhage and ecchymosis takes place in many textures, and visits one after another. The whole organism, in fact, becomes leaky, yet without the blood-vessels themselves being in any diseased state.

Scurvy.—To what morbid condition of the blood must scorbutic hæmorrhage be ascribed? The blood has undergone remarkable and significant changes of colour; from the florid red of health, it has assumed a dark brown or green tint; it appears, also, only half coagulated, the supernatant serum being of a livid colour. Again, the red corpuscles are observed by Drs. Ritchie and Buchanan to have become irregular in their outline, their discs more flattened, and more disposed to cohere together and aggregate into large insulated masses, than the corpuscles of healthy blood. These peculiar appearances are denied by other observers, who regard them either as inconstant or altogether absent. Dr. Garrod, for instance, affirms that recent examinations have shown the blood not to be in a dissolved state, as was formerly supposed, but that the globules are normal in appearance, the clot firm and frequently buffed and cupped.

The balance of evidence, however, preponderates in favour of the peculiar colour and fluidity of the blood, and the collapse of the red corpuscles.

The chemical constitution of scorbutic blood is doubtful.

In the present state of Chemical Pathology, according to one authority, *potash* is *deficient.* Dr. Garrod's analyses led him to conclude that the proportion of this alkali is reduced. Other authorities—Becquerel and Rodier—find the proportion of *soda increased* in scorbutic blood, and that of *fibrin diminished.*

Treatment.—Scurvy.—The *preventive* and *curative* treatment of this disease is alike *dietetic.*

It is an undoubted fact that certain articles of diet possess anti-scorbutic properties. Lemon-juice is the grand anti-scorbutic, whereby thousands of persons have been rescued, who otherwise would inevitably have perished from scurvy. 1457 cases of scurvy were sent to Haslar Hospital in the year 1780. Subsequently, in 1795, lemon-juice was provided by order of the Admiralty, through the representations of Sir Gilbert Blane and Dr. Blair. Then only one case of scurvy appears in the hospital returns for 1806; and for 1807, one. Potatoes, whether in a raw state or cooked, are equally anti-scorbutic. Many other articles of diet, more or less in use, are enumerated by Dr. W. Budd, and their anti-scorbutic properties compared. So far, the prevention of scurvy is practicable.

But this kind of knowledge is *empirical;* we are ignorant (as Dr. Budd justly remarks) of the *essential* element common to the juices of anti-scorbutic plants, and in which their efficacy resides. Therefore,

one plant cannot be substituted for another—prior to actual experience of its anti-scorbutic value—with the sure and certain prediction that it will prove equally efficacious, or more so. And why are we still ignorant of this "essential element," and incapable, consequently, of substituting an untried for a known anti-scorbutic? Because the blood-condition essential to scurvy is yet unknown, and that something, by virtue of which various plants are anti-scorbutic, is therefore equally unknown. Accordingly, the prevention of scurvy can be determined only by the results of actual experience.

Mark the further consequences of this empiricism. If *potash* were assuredly known to be the thing in question, it could be procured in almost any emergency from the ashes of any plant or of any wood, and especially, as Dr. Garrod has suggested, from that ubiquitous weed, tobacco, which is rich in potash.

In the present state of knowledge, the commissariat of an army, a navy, or commercial marine—ever liable to be placed in straitened circumstances with regard to all food—are in the dark on this most critical point. In encampments far from home, during sieges and long voyages, the allowance of lemon-juice has perhaps long been exhausted, and fresh vegetables are a dream; when, therefore, under these adverse circumstances, scurvy stealthily threatens, with pallid hue and dejected mien, the light of Pathological Chemistry would supply an unerring guide in search of that yet unknown something—be it potash or whatever else—by which the impending scourge would assuredly be averted. It might be possible, by a simple process perhaps, to extract that needful something from an abundant source at hand, in a locality otherwise well-nigh barren and desolate.

To conclude, on behalf of the prevention of this disease; any new and *untried* kind of food cannot be *substituted*, in an emergency, for another less plentiful; and, should all food run short, then the *essentially* anti-scorbutic constituent cannot be *extracted* from substances perchance close at hand, in which, like a precious pearl, it remains undiscovered, while scurvy is already overshadowing its victims.

Empirical experience is our only resource under these circumstances, and the rules which it authorizes for our guidance are necessarily of a very general character. They are enumerated by Dr. Budd as follows:—

Firstly.—Anti-scorbutic properties reside exclusively in substances of vegetable origin.

Secondly.—These properties are possessed in very different degrees by different families of plants; least so by the farinaceous, as wheat, oats, barley; most so by the succulent, as the aurantiæ, comprising oranges and lemons; lastly, by potatoes.

Thirdly.—The anti-scorbutic property is impaired by the action of strong heat; nevertheless, boiled potatoes are anti-scorbutic (Dr. W. Baly); impaired, also, by vinous fermentation, but improved probably by acetous fermentation.

To show the difficulty of determining the essential treatment of scurvy empirically, I might add, in striking contrast, the conclusions of Sir R. Christison in favour of *azotized* substances, and of *animal* origin, perhaps exclusively, such as milk.

Purpura.—Although resembling scurvy in appearance, the curative treatment of purpura, by abstinence, purgation, and venesection, as

recommended by the late Dr. Parry, of Bath, is altogether at variance with that which is so efficacious in cases of scurvy; and points, therefore, to some essential difference between these two diseases, otherwise allied. The manifestations of both are unquestionably of blood-origin, yet essentially different in this respect; and not until Chemical Pathology has determined the blood-condition *peculiar* to Purpura will it be possible to interpret rightly the whole etiology of this disease. Its rational preventive and curative treatment will follow.

CHAPTER VI.

RHEUMATISM AND GOUT.

Rheumatism.—*Symptoms and Diagnosis.*—Rheumatism is manifested by an inflammation affecting some portion of *fibrous tissue;* the ligaments and tendons around the joints are more commonly selected, sometimes the fasciæ, and very probably the pericardium and endocardium. This inflammation is *specific.* It is denoted, just as common inflammation is expressed, by redness, heat, pain, and swelling; but rheumatic inflammation is distinguished by not tending to the effusion of plastic lymph, nor to suppuration and gangrene; unless, indeed, some other texture besides fibrous tissue shares the inflammation, as synovial or serous membrane, when its products are the same as those of ordinary inflammation.

Fever.—This local condition is preceded by and accompanied with inflammatory fever, in perhaps its highest degree,—contrasting, therefore, in every way with fever of the typhoid type. A strong, rapid, hard pulse; headache without any delirium, excepting when pericarditis or endocarditis ensues; acid perspirations and urine; these are the chief phenomena of rheumatic fever. And this fever not only precedes the local inflammation, but possibly runs its course without any such manifestation.

Blood-pathology.—Rheumatic inflammation, whether exhibited by the joints, the fasciæ, or the heart, is evidently due to the operation of some morbid blood-condition; and for two reasons more especially.

The very fact of the same inflammation affecting, possibly, "many parts"—*e.g.*, many joints—simultaneously, points to the blood as its common cause. So also does the "metastatic" character of this inflammation. Passing from one joint to another—from the shoulders to the elbows, or from the knees to the ankles, perchance back again to the joints first affected, and probably thence migrating to the heart; these and similar alternations of the same form of inflammation betoken some morbid condition of the blood, which, as a reservoir supplying in common all parts of the body, is turned on, as it were, more abundantly (by inflammation), now on this part, now on that. The "symmetrical" distribution of chronic rheumatism, in many cases, affecting as it does corresponding parts of either half of the body, is further evidence of there being a blood-disease in operation; while

such distribution exhibits also the elective power of similar portions of the same texture.

But although the blood, vitiated in some way, is determined to the fibrous texture, by virtue of its elective power, we cannot say what particular ingredient, normal or foreign to the blood's composition, is appropriated thereby. The texture undergoing rheumatic inflammation selects something—but what ?—from the blood.

Judging by the acid state of certain secretions—perspiration, saliva, and urine—during an attack of acute rheumatism, it would appear that an *acid* of some kind prevails in rheumatic blood; and, first suggested by Prout, other authors—Todd, Fuller, C. J. B. Williams, Headland, etc.—have since concurred in believing that this acid is *lactic* acid.

It is urged that as the perspiration contains lactic acid, with lactates of soda and ammonia, and that exposure to cold, checking this secretion, is well known to be frequently followed by an attack of rheumatism, that therefore this disease is due to an accumulation of lactic acid in the blood. But then, sufficient exposure to cold ought invariably to have this effect; or—making allowance for individual peculiarities of constitution—at least in many instances such would be the effect of exposure. Moreover, the not unfrequent spontaneous origin of rheumatism in hospitals, where patients are protected from exposure, is irreconcilable with the theory in question.

Again, it is alleged that primary mal-assimilation—dyspepsia, in fact, of some kind—produces lactic in excess, which accumulates in the blood. But this theory also is not consistent with observation, so far as the absence of any symptoms of indigestion is significant.

Neither has it been demonstrated that lactic acid accumulates in the blood, as the product of secondary textural mal-assimilation; for chemical research has failed to discover any abnormal quantity of this acid in rheumatic blood. And this fact equally tells against the supposition of its accumulation by primary mal-assimilation, or by suppressed excretion of the perspiration.

Nor does *uric* acid superabound in rheumatic blood. Garrod's chemical analyses establish this negative fact. In truth, rheumatic blood is decidedly alkaline.

Treatment.—Preventive.—The essential morbid condition—which, in those subject to rheumatism, is ever in operation as the cause predisposing thereto—being unknown, the evolution of rheumatic symptoms, from time to time, cannot be averted; and as if to show how comparatively unimportant, apart from this knowledge, is that of knowing the exciting and reputed cause of rheumatism, it is useless to avoid exposure to cold, for that alone will never evoke the disease, and if the blood be charged with the unknown poison, it will arise spontaneously.

Curative Treatment.—The same want of exact knowledge as to the nature of the rheumatic blood-poison, renders our remedial measures proportionately aimless. Whatever it be, there is probably, as with other blood-poisons, a natural tendency to elimination from the system by one or more of the excretory organs. Hence, it is not surprising that experience should sanction the employment of medicines affecting the liver and intestinal canal, the kidneys and skin.

In *acute* rheumatism—with high inflammatory fever—it may be necessary, in the first place, to reduce the general circulation by

systemic blood-letting, venesection. Usually, however, a cholagogue dose of calomel, and an aperient saline, will prove sufficiently depletory, and remove also any source of irritation from the intestinal canal. But such measures are preliminary only. Then, the colchicum and alkaline treatment is generally the most effectual anti-rheumatic. Bicarbonate of potash, in large doses—two scruples or half a drachm—combined with the wine of colchicum in doses of ten or twenty minims, may be administered every four hours. The joint-affections may thus subside within an average period of ten days, and the urine becomes alkaline. Sometimes the colchicum producing sickness and purging, it must be discontinued, or moderated; but it is desirable to keep the urine alkaline for two or three days after the joint-symptoms have subsided. This plan of treatment is certainly successful in many cases. In proportion as *synovial* symptoms predominate, or mix themselves distinctly with the fibrous—observes Sir Thomas Watson—in proportion as the disease approaches in its characters to gout, you may expect to be successful with *colchicum*. Dr. Garrod, who originated the *potash*-treatment in large doses, affirms that it greatly diminishes the tendency to pericarditis and endocarditis. Nitrate of potash—still in large quantity, half an ounce to three ounces a day—is the favourite salt with some practitioners; acetate of potash with others. The late Dr. Golding Bird trusted to the latter, given in quantities of half an ounce, much diluted, in divided doses, during the twenty-four hours. In three days only, it has been known to overcome the pain and inflammation, leaving the joints still swollen but placid. Iodide of potassium finds favour with yet other men of experience, surgeons chiefly, and lemon juice has been advocated by Dr. Owen Rees. Both the latter agents answer better in the *less* acute form of rheumatism. All these agents are probably eliminative, principally through the kidneys.

Calomel and opium, quickly pushed to slight salivation, is another plan of treatment. It would seem to be preferable in cases having a tendency to cardiac inflammation. Opium is, perhaps, most remedial in all cases of acute *fibrous* rheumatism. Sir Dominic Corrigan has great confidence in its efficacy. Beginning with one grain, repeated at short intervals in the twenty-four hours, he gradually increases the quantity up to an average of twelve grains during that period; and continues it until the disease declines.

In *chronic* rheumatism, the compound powder of ipecacuanha (Dover's Powder), guaiacum, and sarsaparilla have reputed efficacy. It would be useless to extend the list. The general nature of the treatment of this disease, acute and chronic, may be gathered from the foregoing observations.

Local treatment can scarcely be of any avail for a disease which, apparently, naturally expends itself by inflammation of whatever part or parts may become affected. Assuredly no repressive application can be salutary. Warm fomentations are calculated to lead the inflammation, as in all other cases, to an issue by resolution. Alkaline fomentations, and especially with an alkaline and opiate solution, are found to be even more conducive to this termination. Dr. Fuller, who strongly advocates such an application, usually employs a solution of carbonate of potash or soda, about half an ounce, in nine ounces of hot water, adding six drachms of liquor opii sedativus. Flannel steeped

in this hot lotion is wrapped round the inflamed joints, and then encased with thin gutta-percha. Chronic rheumatism, attended with thickening and stiffness of the joints and fasciæ, may be somewhat ameliorated by warm baths, vapour baths, shampooing, or frictions. The Turkish bath will thus prove beneficial, provided there be no heart affection of consequence.

Gout.

Gout is a blood-disease allied to rheumatism, but differing in its pathology and treatment.

General Symptoms and Diagnosis.—This disease is manifested by an inflammation affecting the joints, very commonly the first joint, or *ball*, of the great toe.

Commencing, usually, when the individual about to suffer has retired to rest, and has enjoyed some hours perhaps of sleep, he is awoke with fixed pain in one of his feet,—mostly, as I have said, in the ball of the great toe, but sometimes affecting the heel, instep, or ankle. With this pain, cold shivering is generally experienced, succeeded by heat, as the pain, boring, grinding, and wrenching, fastens more and yet more firmly on the spot of its election. "Place your joint in a vice," said a witty Frenchman, "and screw the instrument up until you can endure it no longer. That will represent rheumatism. Then give another twist, and you will somewhat realize gout." The skin over this part is acutely tender, red, tense, and shining, encircled by some œdema, and by converging turgid veins. Much restlessness and excitement supervene. In vain the sufferer seeks to relieve himself of the weight of his bedclothes upon the part inflamed; in vain he shifts his foot from place to place in search of a cool and easy position. The pain, remorseless, grapples yet more tightly. At length, in the course of twenty-four hours or so, it loosens its hold gradually, perhaps suddenly. The sleepless excitement also then subsides, and the victim enjoys some temporary repose. He wakes again to undergo punishment. The toe-screw is reapplied, it may be with a turn or two less; and day by day a slighter punishment is inflicted, until at length the full penalty has been paid. The cuticle peels off the part affected, for gouty inflammation ends by resolution; it never terminates by the effusion of plastic lymph, suppuration, or gangrene. In these respects, this inflammation and that of rheumatism are similar.

Eventually, after frequent attacks of gouty inflammation, the cellular texture around the joint usually becomes pervaded with a deposit of urate of soda, forming concretions, at first pultaceous, then "chalk-stones," of perhaps considerable size. The nodular fingers and toes of chronic gout is a matter of common observation. The skin over these nodules being stretched, at length breaks, and the chalky concretions are laid bare. Urate of soda has been found infiltrating all the textures of one or several joints, in synovial membrane, cartilage, the heads of bone, and ligaments; and usurping their place, the articulations are irreparably destroyed.

Premonitory symptoms refer to the functions of the stomach and kidneys, more especially. Dyspepsia, denoted by inappetency, eructations, heartburn, and acidity of the saliva; together with scanty urine, clear, high-coloured, and containing *less* than the average amount of *uric acid* or none at all; these symptoms portend a fit of the gout. An

intolerable lowness of spirits, with general restlessness and peevishness, are not unfrequently additional warnings.

Blood-pathology.—Chemical analysis demonstrates the presence of an *excess* of *uric acid*, with no other change, in the blood. The absolute test of "blood-disease" having been thus supplied in this instance directly, it supersedes the occasion of any other evidence. But I might point to facts such as these:—Gout visits "many textures" and parts of the body "simultaneously" or in "succession."

According to Dr. Garrod's original observations, the blood in gout always contains uric acid in abnormal quantities and in the form of urate of soda, which salt can be obtained from it in a crystalline state. It arises, apparently, from mal-assimilation,—primarily, of albuminous food in the course of digestion, or secondarily, in the metamorphosis of muscular texture. Or, it may denote simply an excess of animal food over the wants of the system. And the fact first disclosed by Garrod's analyses of the blood, coupled with the known phenomena of arthritic inflammation, inducing the formation of urate of soda concretions, and abundant deposit of urates in the urine, constitute a series of facts, which plainly declare the pathology of this disease. An attack of gout is an effort of nature—of the restorative power—to expel a poison, uric acid, from the blood. Sir Thomas Watson well describes this struggle. "Morbific matter (it may well be called a *poison*) is generated, or detained, under certain circumstances, within the body, and silently collects in the blood; until, after obscure threats, perhaps, and prelusive mutterings, it explodes in the foot; and then the bodily economy, like the atmosphere after a thunder-storm, is for a while unusually pure and tranquil."

Or, gout may engage many joints at once, or flit from one to another; or wander about, disturbing the heart, the lungs, and the brain. Hence palpitation and syncope, dyspnœa, disturbed vision and hearing, with cerebral commotion, bordering on apoplexy and paralysis. This is known as *irregular*, lurking, or masked gout. Sometimes, however, having settled in the foot, it suddenly disappears, and migrates to the stomach, heart, or brain; *retrocedent* gout as it is then called, being unlike the retreat of an ordinary foe, an assault on the very fortress of life. Less perilous migrations are witnessed, when gout betakes itself to the urethra, occasioning a scalding discharge; to the testicle, constituting one form of orchitis; to the eye, giving rise to ophthalmia.

All these manifestations of irregular and migratory gout should be borne in mind, otherwise the disease in some form might be overlooked.

In whatever shape gout may have appeared, whether regular, disguised, or migratory, its decline is marked and measured by a flow of urine, surcharged with uric acid, thus relieving its accumulation in the blood.

Detection of Uric Acid in the Blood.—The ready method proposed and practised by Dr. Garrod for this purpose, and for which the abstraction of only a very small quantity of blood is requisite, he thus describes as the "uric acid thread experiment;"

"Take from one to two fluid drachms of the serum of blood, and put it into a flattened glass dish or capsule; those I prefer are about three inches in diameter, and one-third of an inch in depth: to this

add ordinary strong acetic acid, in the proportion of six minims to each fluid drachm of serum, which usually causes the evolution of a few bubbles of gas. When the fluids are well mixed, introduce a very fine thread, consisting of from one to three ultimate fibres, about an inch in length, from a piece of unwashed huckaback, or other linen fabric, which should be depressed by means of a small rod, as a probe or point of a pencil. The glass should then be put aside in a moderately warm place until the serum is quite set and almost dry; the mantel-piece in a room of the ordinary temperature, or a book-case, answers very well, the time varying from twenty-four to forty-eight hours, depending on the warmth and dryness of the atmosphere.

"Should uric acid be present in the serum in quantity above a certain small amount, it will crystallize, and during its crystallization will be attracted to the thread, and assume forms not unlike that presented by sugar-candy on a string. This may then be examined by a linear magnifying power of about fifty or sixty, procured with an inch object-glass and low eye-piece, or a single lens of one-sixth of an inch focus answers perfectly. The uric acid is found in *rhombs*, the size of the crystals varying with the rapidity with which the drying of the serum has been effected and the quantity of uric acid in the blood."

An amount of uric acid equal to at least 0·025 grains in 1000 grains of serum, in addition to the trace existing in health, must accumulate before this experiment gives indication of its presence. *Premonitory* symptoms, however, coupled perhaps with the signal given by this test, announce that gout is impending.

Hygienic Causes.—Certain habits of life predispose to gout, and certain other habits of an opposite character have an opposite tendency. Indulgence in animal food more particularly, and stimulating drinks; generally, in point of fact, what is called "rich living," together with a sedentary, idle life; these are the acknowledged parents of gout; while moderation in the "pleasures of the table," even abstinence, with a life of active exercise, has no such offspring. Luxury and ease have long since been mistrusted as unqualified advantages compared with the apparent hardships of earning daily bread, by daily labour; so much so, that Abernethy's pithy advice, "Live on sixpence a day, and earn it"—pointing, as it does, to the two elements, food and exertion, in relation to gout—has passed into a proverb.

Treatment.—Preventive.—The regulation of diet according to exercise—of bodily supply to expenditure—is the preventive measure furnished by *experience.* But experience is insufficient for practical purposes. It affords no clue to the right understanding of the physiological relation subsisting between food and exercise, nor of the pathological relation between these hygienic requirements, and which guides the rational prevention of gout.

Physiological Chemistry having first demonstrated the fact that all kinds of animal food, more especially, furnish uric acid in their transit through the body, by indigestion, or by metamorphosis of the muscular textures, it becomes obvious that the balance between the production and elimination of uric acid can alone be adjusted and regulated by a supply of animal food in proportion only to the textural waste from bodily exercise.

Then, Chemical Pathology contributed the additional and complemental fact, that uric acid existing as urate of soda in abnormal

excess in the blood, is the *materies morbi* of gout. Obviously, therefore, the preventive measure which should be directed against such accumulation is this:—*To allow only that particular amount of animal food which, with daily exercise in proportion, will preserve the blood free from uric acid, short of the trace existing in health.*

Now this goes a step beyond mere experience. Guided by an exact knowledge of the *essential* morbid blood-condition from whence proceed all the phenomena of gout, we are enabled so to regulate the health as to prevent this disease. Exact information of the blood-condition, respecting any individual in question, can be readily obtained by abstracting a very small quantity of blood for analysis, or by examining the serum exuded under the application of a blister.

Moreover, by this *scientific* knowledge we are led to rationally administer certain medicines in aid of our hygienic preventive measures. Alkalies—of which the bicarbonate of potash is perhaps the most efficacious for prolonged use—may be administered daily, to neutralize any fresh accession of acid; and colchicum, as a diuretic, will aid the elimination of urate of soda by the kidneys. The mineral waters of Vichy, Wiesbaden, and other places of known repute, owe their virtue chiefly to similar qualities; but in speaking of the *principle* of prevention, I need not enter further into detail.

To illustrate the prophylactic management of gout, Dr. Garrod relates a case, on the authority of Sir H. Halford, in which colchicum with quinine taken in moderate doses daily, gave immunity for two years, when previously scarcely two months elapsed without an attack.

Curative Treatment.—Having due regard to the origin of the gouty *diathesis*—by mal-assimilation, primarily or secondarily—hygienic measures are also curatively important. A reduced proportion of animal food is obviously the leading curative measure, and active exercise daily to increase the elimination of any excess is equally necessary.

No remedial measures are at present known for directly correcting mal-assimilation in respect to lithic acid or other products. The effect of increased bodily exercise may be to increase the destructive metamorphosis of the highly nitrogenous textures, *i.e.*, muscle, and thus directly increase the production of lithic acid: but this may also react beneficially in subsequently correcting the mal-assimilation.

Lithic acid passing off in the urine as lithate of ammonia, the latter is liable to be decomposed by the action of any free acid present in the urine; and lithic acid being insoluble, it appears as a deposit of reddish-yellow sand, consisting of crystals, which may aggregate and form a calculus. The administration of alkalies to neutralize the acidity of the urine is indicated, of which bicarbonate of potash is, perhaps, the best for oft-repeated use. Other alkalies employed for this purpose are the bicarbonate of soda, the acetates, tartrates, and citrates of soda and potash, phosphates of soda and ammonia, and borates of soda and potash. Hence the therapeutic efficacy of various mineral waters, to which gouty patients resort: the waters of Vichy, Homburg, Wiesbaden, Carlsbad, Kissengen, and Aix-la-Chapelles. Conversely, the removal of any source of acidity is also indicated; but this refers chiefly to hygienic considerations. Thus, with regard to food, the vegetable acids, or that which will form them, as sugar or starch in the food, should, in Dr. Bence Jones's opinion, be pro-

hibited. On the other hand, free perspiration should be promoted, to eliminate the acids of the sweat, the retention of which would precipitate uric acid in the urine, and thus lead to the formation of calculus. Warm clothing, warm bathing, friction with horse-hair gloves and belt—an excellent stimulant—and diaphoretics, are therefore most efficacious adjuncts in the treatment of the gouty diathesis.

Lithate of ammonia being soluble in urine at the temperature of the body, its solution is secured, provided only that fluid be not over-charged. Dilution of the urine will best prevent supersaturation and deposit. The free use of aqueous drinks or soda water, is calculated to fulfil this indication, and thus probably prevent the formation of a lithate of ammonia calculus.

Diuretics, which increase the secretion, will also aid the dilution of the urine; and in both ways tend to eliminate lithic acid or lithates from the system. The wine of colchicum, in doses of ten minims and upwards three times a day, prescribed with the carbonate of potass to keep the lithic acid in combination—the resulting lithates being further held in solution by the administration of diluents—will together carry off both, and soothe the irritability of the bladder which accompanies their discharge. Saline aperients seem to aid this desirable result. Any prolonged subjection to such a cause of elimination, requires also the simultaneous action of small doses of blue pill, apparently to maintain the secretion of bile, which otherwise being retained as compared with the secretion of urine, would disturb the balance of their constituents in the blood.

DISEASES OF CONTAGIOUS ORIGIN.

CHAPTER VII.

By the general term Contagion is meant the communication of Discase, either by external contact with morbid matter, perhaps of an imperceptible kind, or through the inhalation of such matter in the atmosphere by the act of breathing-in, which is sometimes distinguished as Infection. The disease produced by the former mode of contact is not necessarily constitutional, but, possibly, merely a local affection; *e.g.*, Itch, as contrasted with secondary or constitutional Syphilis.

Certain Diseases of the Blood, which come within the province of Surgery, are naturally associated, as being Contagious, or the offspring of Contagion; Syphilis, Erysipelas, Pyæmia, Hospital Gangrene, Hydrophobia, Snake-bites, Malignant Pustule, and Glanders. Of these diseascs, the first four are derived from the *human* species, the remaining four from *animals*. This distinction allows a corresponding division of the whole class.

Syphilis.

Syphilis is essentially a blood-disease, produced by the introduction of specific virus or poison into the general circulation. Its introduction, by local contact or by inoculation, is attended with certain tolerably definite manifestations in the skin or mucous membrane of the part, and in the proximate lymphatic glands, in the form of chancre and bubo, respectively,—constituting *primary* or *local* syphilis; while the consequent blood-disease is manifested by certain tolerably definite inflammatory modifications of nutrition in the skin, mucous membranes, eyes, testicle, periosteum, bones, and other parts,—constituting *secondary* or *constitutional* syphilis. But the term *Syphilis* is also understood to signify an entirely constitutional disease; the term *Chancre* being restricted to the primary lesion or ulcer at the point of inoculation of the virus, which, followed by lymphatic absorption, in the form of bubo, gives rise to systemic infection or Syphilis. The so-called *Chancroid*, or simply *Local Contagious* Ulcer, would thus be distinguished from Chancre, by the absence of systemic infection. Gonorrhœa has long been recognised as an entirely distinct disease, arising from the contagion of another species of virus, which produces an inflammatory discharge from the urethral mucous membrane, of a contagious character, but which does not infect the system. These three diseases, Syphilis, Local Contagious Ulcer, and Gonorrhœa, alike arising from impure sexual intercourse, are included under the common term—*Venereal* Disease.

Primary and Local Venereal Ulcers.—(1.) *Chancre,* and its *Diagnosis.*—Chancre is a primary *syphilitic* sore or ulcer. After exposure to contagion or inoculation, a period of *incubation* ensues, during which nothing is discernible, and the individual thinks himself well. The duration of this period varies, averaging from two to three weeks, and being rarely under a week (H. Lee), but, perhaps, extending to five or six, and very rarely to eleven weeks. (Bumstead.) Then the primary manifestation of syphilis begins. Commencing with a trifling itching, affecting usually some spot in the furrow at the base of the glans penis, near the frænum, or it may be on the prepuce or the skin of the penis itself; there soon appears, as the initial lesion, a small pimple, whose summit speedily becomes a vesicle, containing a thin transparent fluid-lymph, or becoming thicker and opaque—in fact, purulent—when subject to irritation. The vesicular stage of chancre is seldom met with. I have seen it only twice. This vesicle or pustule bursts and forms an ulcer. If the syphilitic virus be introduced through a crack or abrasion, which may happen in the act of intercourse or have existed previously, the chancre forms an ulcer, without any incipient pimple or vesicle; obviously because the cuticle there raised by secretion, was here removed.

The primary syphilitic *ulcer* may appear in either of two forms. (*a*) A *superficial erosion,* flat or elevated, when the subjacent induration has taken place. The shape of this sore is circular, but sometimes irregular; and it has a smooth or polished surface, of a red or greyish colour, overspread with a discharge consisting of lymph-globules and epithelium scales. Or, (*b*) the ulcer presents a small circular *cup-shaped cavity,* having a smooth, red interior, without granulation, and discharging a thin serous fluid, or glazed with a little adhesive lymph, and set in apparently healthy texture. About the end of the first week, and never before the third day, chancre becomes *indurated,* and circumscribed, like a split pea, by an effusion of plastic lymph beneath its base, and around the ulcer; its colour now having a fawn hue, or assuming various shades of brown or red, according to the secretion. A single exception is met with in chancre on the glans penis, which rarely acquires induration. It is here simply a spot denuded of cuticle, and having a red, moist, glistening, flat surface. (*c*) Occasionally, no ulcer is produced, nor perhaps any discoverable breach of surface; but induration appears in the form of a hard knot or tubercle, imbedded, and covered with epithelial scales.

Diagnostic value of Induration.—When confined to the *base* of the ulcer, induration of an elastic, cartilaginous hardness, and terminating abruptly, was regarded by Hunter as characteristic of true chancre. Yet he acknowledged that this indurated base is not peculiar, being common to other indolent ulcers. When affecting the texture *around,* as well as the base of the ulcer, M. Ricord regards cartilaginous induration, thus disposed, as absolutely pathognomonic of "*infecting* chancre," or that species which accompanies and denotes constitutional syphilis. This kind and form of induration is, indeed, the local expression, by chancre, of the syphilitic blood-disease,—the first *secondary* symptom. The latter doctrine is supported by the authority of Professor Bumstead, of New York, and Mr. H. Lee, and is now generally accepted.

On the other hand, the fact should not be overlooked that precisely

the same condition of induration may be produced artificially, by irritating applications; such as kali purum (Hennen), corrosive sublimate (Acton), and better still, says Ricord, by chromate of potash, nitrate of silver, or the nitric and sulphuric acids; "so as to deceive even the most careful and experienced practitioners."

The *duration* of chancre, as an open ulcer, is commonally a period of some weeks; it continues often until after the appearance of secondary symptoms, and being thus indolent and indisposed to heal, it then cicatrizes slowly and perhaps imperfectly; or the sore may reappear. Induration remains for a longer period, usually for at least two or three months; espcecially when the chancre is situated in the furrow at the base of the glans penis. As instances of extreme persistence may be mentioned induration of two and three years, in several cases known to Bumstead; nine years, in a case seen by Puche; and thirty years, in one instance, according to Ricord. On the other hand, induration may disappear before the chancre heals, leaving a perfectly soft base to the cicatrix. This occurs particularly in the parchment form of hardness, around a superficial chancre; the deposit being limited to the mucous membrane, without involving the subcellular texture, it is soon resolved.

The *termination* of chancre is not attended with any loss of substance, and thus there is no marked cicatrix. When situated on the skin, as the outer aspect of the prepuce, a brown or dusky-red discolouration often remains, which, however, at length fades away into a white colour.

Chancre is generally solitary; although sometimes more than one such sore may be produced. It is protective against the recurrence of a similar sore, conferring a relative, but not an absolute, immunity against subsequent attacks. Thus, inoculation with the secretion of chancre fails to reproduce chancre in the same person, or in another person already affected; in other words, chancre is neither capable of *auto*-inoculation, nor of *hetero*-inoculation; the reason of non-reproduction being, apparently, that the system or constitution is already under the influence of the syphilitic virus—syphilis is established. Whenever the discharge from an indurated chancre proves to be inoculable, it never begets a similar sore, but only a pustule, and then some slight erosion or ulceration. The failure of reproduction may, therefore, be regarded as diagnostic evidence that the ulcer is not a chancre.

But it should be observed that no one character of chancre is invariably constant, nor peculiar to this species of ulcer, and, therefore, not absolutely pathognomonic; neither its period of incubation, its circular shape, its induration, its indolence, nor its protective power, and non-inoculable nature. Taken collectively, however, and in conjunction with an indurated or a bullety-hardened enlargement of the neighbouring lymphatic glands, forming a multiple indurated bubo, the ulcer is then recognized as a chancre. The co-existence of secondary symptoms in constitutional syphilis, will of course strengthen the diagnosis.

(2.) *Chancroid, or the Local Contagious Ulcer.*—Commencing as a pustule, which bursts, or occasionally as an open sore, the ulcer formed has a circular shape, as if punched out; but the base presents a cellular or honey-combed, worm-eaten appearance, and is covered with a

greyish-yellow membranous secretion, consisting of disintegrated texture and pus-globules; and the margin of the ulcer is a little undermined and vertical, instead of sloping inwards to the base, as in hard chancre. No induration ensues, so that when the prepuce, for example, is retracted, the ulcer bends upon itself, instead of rolling over *en masse*, like the indurated chancre; and on raising the sore between the thumb and finger, it feels quite soft and doughy, its edge and base moving easily, and a little pus oozes out; it is a *soft* and *suppurating* ulcer, the "soft chancre," or the "simple, non-infecting chancre," so named by Ricord. Attended with some loss of substance, the ulcer heals by granulation, generally in a shorter period than chancre, and cicatrization leaves a depressed and permanent scar.

This soft, suppurating sore has no period of incubation; it appears from two to four, rarely five days, or within a week, after exposure to contagion. Chancroid is much more common than chancre; perhaps in the proportion of 4 to 1, though some say 3, or only 2 to 1. It may be solitary, but is often multiple; and it affords no protection against recurrence, conferring no immunity whatever for the future. The ulcer is reproductive by inoculation, and the reproduced sore can be propagated in like manner. Hence, this fact supplies a diagnostic test of chancroid; or, as often happens accidentally, the purulent secretion affects contiguous parts. The ulcer is sometimes associated with a soft and suppurating enlargement of a neighbouring lymphatic gland, as in the groin—a suppurating bubo.

The possible *co-existence* of chancre and chancroid—the indurated and the soft, suppurating ulcer—or of either species with gonorrhœa, must not be overlooked. And the co-existence of the two species may occur in the *same* sore—a suppurating ulcer, with an indurated base, an auto-inoculable discharge, and which is capable of communicating syphilis to an uninfected person. Such is the *mixed* chancre of Rollet and the French school. The consequent bubo may be both indurated and suppurating.

Mixed chancre is produced by double inoculation, occurring perhaps at the same time; as in sexual intercourse, when a healthy man has connection with a woman having both a chancre and a chancroid; or the inoculation of either species may be engrafted upon a pre-existing ulcer of the opposite species. In either case, when fully developed, mixed chancre can be propagated, in both its kinds, by successive inoculation from one person to another. But prior to full development, when double inoculation has occurred, chancroid first appears, which by contagion will only reproduce itself; and towards the close of ulceration, whichever kind of sore lasts the longest, it will reproduce itself only. Chancroid may be contracted by an individual affected with secondary or tertiary syphilis; and the ulcer then retains its identity of character, and runs its course.

An apparent *interchange* of the two kinds of ulcer is liable to happen, temporarily, from various accidental circumstances; so that the chancre, even when indurated, may perchance suppurate for a while, owing to some cause of irritation; and the soft sore may, for a time, become somewhat hardened by irritation, although it still discharges a purulent fluid. But, when the disturbing cause is removed, either kind of ulcer re-assumes its original and distinctive characters.

The *conversion* of indurated chancre into the soft chancroid ulcer, would seem to be an admitted possibility, according to the view advocated by M. Clerc, and other observers; that the soft sore is a derivative from hard chancre, as resulting from the transmission of the syphilitic virus through the system of a person who had already undergone syphilitic infection. This relation of chancroid to chancre would be analogous to that of the varioloid eruption to variola, or of the false to the true vaccine pustule.

Diseased Conditions of Chancre, and Chancroid Ulcer.—Either of these specific ulcers may assume the characters of some ordinary form of ulcer, under circumstances referable to the state of the general health, and that of the digestive organs in particular. Thus, the ulcer may become *irritable*, or painful and disposed to bleed; if *inflamed*, the usual appearances of this kind of ulcer are presented. *Phagedænic* chancre appears as an irregular sore, with sharp, undermined edges, and a worm-eaten surface, covered with a white or black slough; *serpiginous* phagedæna is a variety distinguished by the creeping character of the ulceration, its unlimited extent and duration; and *sloughing* or *gangrenous* phagedænic chancre has the mixed characters which its name implies. The three last conditions of ulceration are very destructive, especially the latter variety. When affecting the prepuce, this part becomes greatly swollen, brawny, and dusky red; but the phimosis or contracted state of the preputial orifice, conceals the ravages beneath; a black patch appears, and sloughs, disclosing the glans, or if the foreskin be slit up with a bistoury, the phagedænic ulcer is discovered, and perhaps only a remnant glans.

The existence of *chancre*, as an ulcer having any distinctive characters, has been altogether denied by many observers of known accuracy and large experience. First: Rose (1817), whose experience in the hospital of the Coldstream Guards ranged over a large number of cases, admitted that although there are many symptoms common to chancres, they are not entirely peculiar to them. Hennen (1829) acknowledged with regret that there are "not any invariable characteristic symptoms by which to discriminate the real nature of the primary sore;" and, having witnessed many instances of self-deception, in attempting to diagnose a sore for the cure of which mercury is indispensable, from one of a different nature, he repudiated the pretensions of those who assume to themselves the possession of a *tactus eruditus* by which they can distinguish this kind of chancre. Recurring to the diagnosis of chancre, rather than the kind, Mr. Bacot's experience (1829) led him to affirm, that chancre may present every variety of appearance to which a breach of surface is subject; and Colles (1837) stated, "as the result of long, attentive, and anxious observation," that primary venereal ulcers present an almost endless variety of character. To this effect also were the observations of Wallace (1838); for, says he, neither the mode of origin, nor the form, nor the colour, nor the size, nor the number of the ulcers of primary syphilis, are pathognomonic. Acton (1851) avowed it was incontrovertible, that other sores, not of a specific nature, may assume all the aspect of real chancres; and Labatt (1858), considering the great variety of appearances presented by primary ulcers, experienced the difficulty of classifying them, and confessed that hitherto every such attempt had ended only in disappointment.

Mr. H. Lee recognizes four different *morbid processes* and corresponding forms of Primary Syphilis :—

First.—The inoculated part may become affected with the *adhesive* form of inflammation, in which lymph is poured out either in the substance or on the surface of the part.

Second.—The inoculated part may, within a few days of the application of the poison, be affected with *suppurative* inflammation.

Third.—The absorbents may assume an active share in the morbid process, and taking up some of the infected parts, and with them portions of the syphilitic poison, produce an acute inflammation of a lymphatic gland. This form of the disease is termed *ulcerative* inflammation.

Fourth.—The morbid action may terminate in *mortification.* Of this there are two practical subdivisions :—

(*a*) Death of the whole infected part, which is then thrown off as a slough; (*b*) Dissolution and death of a part only of the contaminated structure, leaving a part still infected.

Situation.—The external parts of the *genital* organs are obviously the common situation of the chancre, and some parts are more especially liable. Thus, in the *male*, that portion of the penis is commonly the seat of chancre, which having been exposed in sexual intercourse, is apt to retain any secretion with which it came in contact. Hence, the furrow between the glans and prepuce, and perhaps near the frænum is the most frequent situation; but chancre may form on the inner surface, or at the margin of the prepuce, or on the frænum ; sometimes on the glans, or at the orifice of the urethra, or perchance on the skin of the penis. *Urethral* chancre is, however, not unfrequently met with ; the chancre being situated immediately within the orifice of the urethra, or higher up in the canal. In the one case, it may easily be seen on just everting the lips of the urethral aperture; in the other case, it can be felt as a more or less nodulated induration of the urethra when pressed between the thumb and finger. Chancres thus situated have been found by Ricord to extend along the whole canal up to the bladder, in rare cases. Urethral chancre emitting its discharge from the external orifice, may be mistaken for gonorrhœa ; but, while their diagnosis cannot be determined by the variable appearance of the discharge, inoculation will evince its true nature; a chancre being produced if the matter be syphilitic, and not by gonorrhœal discharge. The presence of a nodulated induration in the urethra will corroborate the diagnosis.

In the *female*, also, the external genitals are the common situation of chancre, as just within the labia minora; less frequently on the mucous membrane of the vagina, or on the os uteri or within the cervix. Examination will readily discover a chancre when situated externally ; but the speculum must be used to detect the presence of a vaginal or uterine chancre. In certain *unnatural* situations, chancre may occasionally be found ; as at the anus, or on the lips of the mouth ; suspicious of practices which need not be named.

Bubo, and its *Diagnosis.*—Bubo is a generic term, signifying a swelling of the lymphatic glands, and specially those of the groin (*βουβων*, the groin), of an inflammatory character, acute or chronic, and with or without suppuration. It may arise from any cause of local irritation, affecting the lymphatic vessels continuous with the

glands, producing sympathetic bubo; or proceed from the absorption of poisonous matter, or virus; or it may depend on constitutional causes, as scrofula.

(1.) *Syphilitic* or *Indurated* bubo denotes absorption of the syphilitic virus from the primary sore, which, on its way to the blood through the absorbents, irritates the nearest absorbent glands —commonly the inguinal—whereby they become swollen and hard, and perhaps suppurate. Compared with chancre, bubo can scarcely be called a *primary* symptom, for although the time of its accession after chancre is uncertain, it is always somewhat *later*.

On the other hand, it has been held that bubo may possibly arise from direct absorption, without the previous formation of chancre; that bubo may thus be the only primary symptom. Such buboes, therefore, have been named "primary buboes," and by the French, "bubons d'emblée." But the existence of non-consecutive bubo, as indicative of true syphilis, is inconsistent with the present state of knowledge; although a simple inguinal adenitis may arise without any appreciable lesion of the genitals.

Indurated bubo begins at a period of about eleven days (Rollet), and never later than two weeks (Ricord), after the commencement of chancre; or, usually, at a somewhat earlier date, the time when induration of the base of the chancre takes place. (Bumstead.) It appears as a hard, bullety, and scarcely painful swelling of the lymphatic gland, nearest to the spot whence the poison was absorbed; the absorbents themselves proceeding to the enlarged gland, share this inflammatory induration, and sometimes feel like hard whipcord. Along the back of the penis, such cords may be felt leading to the groin, where generally, just above Paupart's ligament, lies the swollen, bullet-like gland. In the female, if a chancre be situated on the fore part of the vulva, this swelling is found at the external abdominal aperture; if situated posteriorly, then betwixt the labium and the thigh, inflamed lymphatic vessels lead to a swollen, hard gland in the groin. Commonly, as Bassereau observes, more than one gland is affected, forming a *multiple* bubo, of small olive-shaped or globular tumours, having a cartilaginous hardness, and which are freely moveable upon each other, being unattached to surrounding tissues, or to the overlying integument; and this little mass corresponds in direction to the inguinal fold. Almost painless, or only slightly tender, it does not interfere with walking. Sometimes the bubo is situated on the opposite side of the chancre; or both groins may be affected, presenting double inguinal bubo. Chancres within the urethra, on the perineum, the anus, the mouth or neck of the uterus, the lower part of the abdomen, or the buttocks, are equally associated with inguinal bubo. But, when the vessels of absorption pass through other than the inguinal glands, the bubo will be situated elsewhere. Thus, Hunter saw a syphilitic bubo far down on the thigh.

The *course* of indurated bubo is slow; reaching its full development in a week or two, its ultimate duration varies from several weeks to five or six months (Bumstead), or may be prolonged even to a period of years. (Ricord.) Like chancre, it is thus essentially indolent and usually more persistent. It *terminates* by resolution; suppuration is a rare event, having occurred in only sixteen out of 383 cases, according to Bassereau, while Fournier met with only two in 265 cases.

This species of bubo almost invariably follows a chancre, itself indurated; follows it, observes Ricord, as a shadow follows a body; and the constancy of this sequence is attested by Fournier's report, that 265 cases of chancre were succeeded by bubo in 260, and in only three of these was the absence of induration from the outset certain. This constancy of connection with indurated chancre confirms the diagnosis as to the nature of the bubo. But, occasionally, induration may arise from some other disease; thus far simulating syphilitic bubo. Scrofulous enlargement of the inguinal glands exhibits a somewhat hard and indolent swelling; the accompanying constitutional condition and history are, however, distinctive of scrofula. Cancerous enlargement of the glands will probably be connected with cancer of the penis.

(2.) *Inflammatory Bubo.*—Arising from any cause of lymphatic irritation, and commonly from gonorrhœa, this species of lymphatic glandular enlargement is then named *simple* adenitis or *sympathetic* bubo; but as proceeding from chancroid ulcer, by the absorption of its virus, it may be designated *chancroidal* bubo, being in fact a chancroid of the lymphatic gland affected; or it is also known as virulent bubo, owing to the contagious character of the pus produced.

Beginning usually within a fortnight after the appearance of chancroid on the genitals, one gland only, or sometimes more, presents a swelling in the groin, but the enlarged gland is somewhat *soft*, never indurated, and decidedly painful, so that the patient walks with a limping lameness; differing in all these particulars from indurated bubo, in connection with chancre.

This state may last for an indefinite period, as an indolent bubo; and then subside by resolution, when resulting from simple adenitis. Or, the gland enlarging, it engages the fascia and skin, whereby the tumour becomes adherent and fixed. *Suppuration* may then ensue from simple inflammation; and chancroidal bubo always proceeds to this issue. The integument acquires a purplish-red hue, and a stretched, shining appearance, while the cuticle is shed in receding circles, and the cutis becomes thinner. At some softer point, fluctuation can be felt, the thin skin cracks, and matter exudes from the interior of the gland, and from around; or the circumferential abscess bursts first, a few days before that within the gland. The ulcer formed assumes all the characters of chancroid; its interior being overlaid with a greyish-yellow membranous secretion, its margin undermined and vertical or everted, while the pus from within the gland is auto-inoculable,—any abrasion of the surrounding skin thus reproducing a chancroid ulcer, or inoculation can be artificially effected. Chancroidal bubo may be thus distinguished from the bubo of simple adenitis, and from the indurated bubo of syphilis,—in the rare form of its suppuration. Associated causes will confirm the diagnosis. Thus, simple adenitis may arise from the local irritation of gonorrhœa, balanitis, vulvitis, herpes, eczema, or other inflammatory affections of the genitals; or from a crack or abrasion in seminal intercourse; from over-sexual indulgence; or from muscular exertion, as in walking, dancing, or rowing; and occasionally, from the presence of a chancroid or a chancre, acting as a source of local irritation, not of absorption. (Bumstead.) On the other hand, chancroidal bubo is connected with a causative chancroid; as indurated bubo is with indurated chancre.

Chancroidal bubo may acquire all the characters of some common ulcer; as the *indurated* and *indolent*, the *irritable*, the *inflamed*, the *phagedænic*, the *serpiginous* form of phagedaena, or the *sloughing phagedænic*. The three latter forms of bubo, originally chancroidal, are more or less destructive; the ulcer sometimes increasing to an enormous size, extending inwards over the perineum, or upwards perhaps as high as the navel, or downwards on the thigh, while its depth may there threaten the femoral artery.

Diagnostic value of Inoculation.—Does inoculation supply *the* positive test of Syphilis? The answer to this question will be yes or no, according to whether or not the so-called chancroid ulcer be acknowledged as a species of chancre. The failure of inoculation to reproduce a chancre upon a person already affected, affords only a *negative* result, as the evidence of pre-existing systemic infection, *i.e.*, of Syphilis; and reproduction of the ulcer by inoculation indicates its locally contagious nature, *i.e.*, its chancroidal character, as distinguished from chancre. Bearing in mind this negative and positive result of inoculation, we are prepared to understand, and to reconcile, the apparently contradictory results of observation respecting the question at issue. The virus or pus from a supposed chancre, or a suppurating bubo, being introduced beneath the skin of any part by a lancet charged therewith, produces another such chancre,—passing through the stages of a pimple, a vesicle or pustule, to the perfectly formed ulcer. Thence, in like manner, another such chancre may be produced. This power of reproduction was known to and used by Hunter, as a test of syphilis. But opinions have ever been divided respecting the diagnostic value of inoculation, just because the chancre and the chancroid ulcers may have been indiscriminately used in the cases submitted to this test. Evans, Bell, Sperino, and other observers have alike insisted on the value of reproduction by inoculation, in order to determine the specific nature of a supposed chancre; and Ricord, who almost accords to "induration" the rank of an absolute sign of the "infecting chancre," yet acknowledges that the individuality of this ulcer, as a distinct species, "exists neither in its form nor in its floor, nor in an absolute manner in any one of its external characters; its nature is in the pus which it secretes. Inoculation is the pathognomonic character of chancre, and which *alone* suffices to establish the diagnosis." But it is now known that Ricord's observations had reference to "simple chancre," *alias* chancroid, or the local, contagious, and soft, suppurating ulcer. That, comparing the indurated and systemic-infecting, true chancre with this chancroid ulcer, as to the results of inoculation, in forty-four inoculations of the latter, on individuals already affected, there were forty-four reproductions of the original kind of ulcer; but that in fifty-five inoculations of the former kind,—chancre,—there were fifty-five sterile results! Consequently, the answer of Inoculation as a diagnostic test, is; of chancroid, positive,—that it is auto-inoculable; of chancre, *negative*,—that it is not auto-inoculable. And this *negative* result of inoculation is so far available in the diagnosis of Syphilis. It is, therefore, probable that the supposed instances of positive result adduced by Dr. Sperino, were from simple suppurating sores, with some amount of accompanying induration. In ninety-nine cases of indurated chancre, in only one instance did inoculation succeed upon the patient who thus had the disease, and that was within a very short

time after contagion. Such is Fournier's experience. Puche could produce auto-inoculation in only 2 per cent. Poissou obtained a similar proportionate result in fifty-two cases of trial; and Laroyeune was unsuccessful in every one of nineteen cases. Bumstead observes that the failure of inoculation is favourable to the supposition that the sore is a chancre.

In the *earliest stage* of chancre, before its specific action upon the patient's constitution has been developed, the result of inoculation may be a specific hardened sore, accurately resembling the original. So far Mr. Lee concedes the positive value of this test. But that as soon as the specific adhesive inflammation has once taken place in a patient, his system is no longer in the same condition as before; he is no longer capable of being inoculated, and inoculation, if attempted, in the vast majority of instances, entirely fails. M. Clerc's observations (1855) lead to the conclusion that even the initiatory sore of syphilis is non-inoculable, in most cases.

The *differential* nature of chancre and chancroid can, however, be readily discovered by inoculation. The power of reproduction is inborn in *chancroid*, and available, therefore, as the test, from the very first formation of lymph, when the chancroid is yet a pustular pimple. Inoculation is the earliest, and the most infallible, criterion of chancroid. What if this method of diagnosis be postponed to a later period? Even then the open suppurating *bubo* is a chancroid, and its pus will produce another such ulcer by inoculation; not the pus secreted in the cellular tissue around the suppurating gland, but that which issues from the gland itself. Here, then, is an additional positive test, diagnostic of chancroid from the negative answer of chancre.

Inoculation should be avoided whenever the patient's constitutional condition is broken down, or the ulcer of a phagedænic character; the site chosen should be some portion of integument not liable to phagedæna, as the skin on the chest; and the inoculated point should be freely cauterized with nitric acid, as soon as the diagnosis of a resulting chancroid is determined. The little operation is thus described by Prof. Bumstead:—Take a clean lancet, moisten its tip with the purulent secretion, and enter the point perpendicularly with a slight impulse, not deeper than to the vascular layer of the skin; the instrument is then turned once round on its axis, and withdrawn, and any remains of the pus upon the blade is smeared over the orifice of the puncture. No after care is required.

Duration of Specificity.—*Chancre* retains its specific nature for a considerable period, frequently weeks, sometimes months,—in one of my own cases, probably eight months, during which time the sore can communicate the disease to an unaffected person. This period of "*statu quo specific*," thus of uncertain duration, extends to when the ulcer cleanses itself, begins to throw out healthy granulations, and to cicatrize from its circumference. These, therefore, are the signs of the loss of contaminating power. *Bubo*, however large, which has arisen from a chancre when about to heal, is simply a swelling of the lymphatic gland, which, as Ricord observed, fails to supply virulent matter in the event of suppuration. *Chancroid*, or the soft, suppurating ulcer, mostly cicatrizes in the course of a few weeks; but the period of repair may be prolonged much beyond, the sore retaining its virulent specificity of local contagiousness up to the last moment of its exist-

ence; while, indeed, cicatrization is proceeding at the circumference, the pus is specific in the centre of the ulcer, and may propagate chancroid in a neighbouring part, or in another person.

But different modes of therapeutic *treatment* will affect the duration of specificity, and must be taken into account. The mercurial and non-mercurial methods of treatment have a different influence on chancre, in this respect, and unfavourable to the former method, in its prolonging or not curtailing the period before healing,—that period being taken as the indication of continued specificity. Thus, to compare the large collections of cases by Sir James M'Grigor and Sir William Franklin. In 1940 chancres collated indiscriminately, and which healed without mercury, the average period was, without bubo, twenty-one days; with bubo, forty-five days; whereas, in 2827 chancres, including a larger proportion of indurated sores treated with mercury, the average period prior to healing was, without bubo, thirty-three days; with bubo, fifty days,—a longer continuance of the specific nature under the influence of mercury.

Syphilis—Secondary or Constitutional.—The blood having become infected with the syphilitic virus, after the appearance of chancre with induration, in the course of a month or six weeks, or a longer period, a constitutional disturbance—the syphilitic fever—ensues, in a degree more or less marked. According to the observations of Dr. Guntz, the period of its accession varies to within fifty and sixty-five days, in the natural course of the disease, unaffected by treatment; but that no fever appears within or even beyond that period, when, from immediately after infection, the patient has been brought under the influence of mercury, used internally or externally.

The symptoms of febrile disturbance are those of ordinary pyrexia; some acceleration of the pulse, a dry, hot skin, and furred tongue; succeeded by great debility, wandering pains, and gradual emaciation, with the wan sallowness of syphilitic cachexia. Occasionally, Guntz has known a violent rigor or shivering fit to precede the symptoms. The temperature always rises considerably, perhaps to $103\frac{1}{2}°$ F., in the first twenty-four hours; then, on the second day, it falls much lower, followed perhaps by evening exacerbations daily, for a long time.

With the *accession* of syphilitic fever, various inflammatory modifications of nutrition are developed, which have a tolerably regular order of sequence, in different parts of the body. As manifestations of the blood-disease in operation, they are "secondary" or even "tertiary" to the chancre and thence the bubo, which, proceeding from the original source of infection, constitute "primary" syphilis.

The slow-healing power of the primary sore, and of an open bubo, somewhat suggest the prevailing character of these secondary manifestations. From the first moment of the pus-forming pimple, the whole career of syphilis is one of *disintegration* of the tissues, with an abortive effort of the reparative power by plastic lymph-forming induration. Disintegration by desquamative or other destructive eruptions of the skin; disintegration, by corroding ulceration of the tonsils, tongue, lips, palate, and perhaps the nose; disintegration, by iritis, with molecular lymph; disintegration, by irreparable destruction of the texture of the testis; disintegration, by caries and necrosis. Premature baldness, fretting ulceration around the roots of the finger and toe nails, and a wan cachectic pallor, bespeak the consummation of syphilitic decay.

During the course of secondary syphilitic manifestations, certain facts respecting the accession of rigors and rises of temperature merit attention. In the eruptive stage, the pyrexia is sometimes associated with repeated rigors, as noticed by Lancereaux; and they may assume an intermittent character—quotidian, tertian, or double tertian. But this intermittent type of febrile disturbance is met with generally in the later stages of syphilis, when deep cachexia has supervened. The temperature rises, perhaps, from time to time, coincident with the extension of skin-eruptions. In the later stages, when syphilitic affections of the bones and joints have ensued, the observations of a committee of inquiry on temperature * led to some notable results; that in the febrile disturbance which usually accompanies, and is proportionate to the amount of joint or periosteal affections, nocturnal exacerbations occur, the temperature rising from one to four degrees, with an equal morning fall. The association of rheumatoid symptoms with an equal outbreak of macular or papular eruption is accompanied with fever, but not with the oscillation of temperature. Iodide of potassium affects the fever remedially, the temperature being reduced within three days after its administration in sufficient doses. In pyæmia, the oscillations of temperature much resemble those noted in syphilitic rheumatoid affections.

Comparing (Secondary) Syphilis in all its various forms, with similar diseases arising from other causes, their resemblance is often remarkable, and their appearances differ rather in degree than in kind. Probably, therefore, none of the manifestations of (constitutional) syphilis, as secondary symptoms, are singly characteristic; but a concurrence of such symptoms—secondary or consecutively—may be diagnostic.

The descriptions given in Mr. Lee's elaborate treatise, with regard to syphilitic eruptions, for the most part amply confirm this general proposition.

(1.) *Skin-diseases.*—Similar eruptions—exanthematous or rashes, papular or pimples, tubercular, squamous or scaly, vesicular and pustular—arise alike, as manifestations of constitutional syphilis in the skin; and also under other circumstances.

Roseola or rose-rash.—The eruption which usually first succeeds the syphilitic fever, is of a rose-red colour, not raised above the surface of the skin, disappearing on pressure, and returning as soon as the pressure is removed. It arises in the form of more or less rounded patches, giving a mottled appearance to the skin; when examined closely, each patch is seen to be made up of a cluster of papillæ, more injected than natural. This eruption sometimes vanishes within a few days. If it persists, the papillæ forming each patch generally become visibly enlarged, and the colour of the eruption gradually changes to a *copper* hue. This colour is commonly present in all syphilitic eruptions which remain for any length of time without suppuration or ulceration; but it is not peculiar to (secondary) syphilitic eruptions, it is not *pathognomonic.* It is, observes Erasmus Wilson, commonly met with in chronic eruptions of other kinds—for example, in acne; and non-syphilitic eruptions often possess more of the dull and muddy copper colour which is generally supposed to be characteristic of syphilis,

* "Trans. Clin. Soc.," 1870. Report by C. Bäumber, A. B. Duffin, Berkeley Hill.

than syphilitic eruptions themselves. Moreover, when present in undoubtedly syphilitic skin-diseases, it does not supervene until their decline.

The eruptions which follow this first efflorescence on the skin, exhibit a variety of appearances.

Lichen, a *papular* eruption.—The papillæ of the skin are enlarged separately, in the form of hard elevations having a copper-colour, which terminate by desquamation or resolution. These elevations may be scattered irregularly over the body, or collected together into groups.

Tubercular eruption.—Effusion of plastic lymph having taken place, it becomes organized, as in the papular eruption, but now in the form of small and tense conical eminences, covered with a red shining cuticle; which gradually acquire a copper tint, and shed their shining silvery scales of cuticle. The tubercles may be scattered singly over the surface, or aggregated into groups.

Lepra, a *scaly* eruption, commences, like the mottled skin of roseola, by the injection of circular groups of papillæ. The papillæ are at first separate, but soon the whole circular patch becomes equally involved; an effusion takes place into the substance of the skin, which then presents a small flat elevation, the edges of which are sometimes raised higher than the centre. A copper colour, of a more or less decided hue, overspreads the eruption, but it is often partially masked by a thin layer of cuticle, which is shed in thin white shining scales, as in common lepra. Numerous patches, all perfectly circular, may form on any part of the body. Patches of syphilitic lepra sometimes much resemble flattened syphilitic tubercles.

Psoriasis—another *scaly* eruption—appears in the form of oval or irregular patches, slightly elevated above the surface. They are not depressed in the centre, and are often traversed by cracks or fissures. A copper or brown colour is often observable, but covered with epithelial scales of various degrees of thickness. This disease is much more persistent than syphilitic lepra. It occurs on the palms of the hands and soles of the feet, or on any part of the body.

Vesicular eruptions, as manifestations of constitutional syphilis, are similar to, if not identical with, vesicular eruptions not of syphilitic origin. Thus, in point of their origin only, we recognize *syphilitic* herpes, eczema, and pemphigus or pompholyx. In all, an effusion of serous fluid raises the cuticle into vesicles, or blebs—bullæ, which are simply large vesicles such as form in the last-named form of eruption. But the diagnostic characters of syphilitic vesicular eruptions are even less peculiar than those of the eruptions already noticed.

Pustular eruptions constitute also an analogous class to the non-syphilitic. They, like eruptions generally, may arise from the transformation of other eruptions, in the course of syphilis. Thus, the papular may change into the vesicular, and this pass into pustular.

The proper pustular eruptions of syphilitic origin are divided by Cazenave into three kinds:—

(*a.*) *Psydraceous* pustules, which are either small and narrow, or of large size, elevated, and round. They have a hard base, and are surrounded by a copper-coloured areola. The pustules are of a dull reddish hue, and are developed in successive crops; showing examples of the disease in its origin, maturity, and decline. Their progress is slow, and the accompanying inflammation moderate. In some cases,

however, it destroys the true skin, and leaves a small, white, circular scar, depressed in the centre, and not larger than a pin's head. This form chiefly occurs on the face and forehead, where it somewhat resembles acne rosacea, but it may appear on every part of the surface. The pustules dry into a small greyish scab, which separating, may leave either a cicatrix or some injection of the skin.

On the limbs, psydraceous pustules are of the size of a lentil, but slightly elevated above the surface, with a hard base; and they contain a very small quantity of yellowish-white matter, contrasting with the copper-coloured elevation on which it rests. They are not followed by ulcers; a thin scab forms on them, which is succeeded by a scar, or sometimes by a livid discoloration, or a small chronic induration.

(*b.*) *Impetigo*, preceded by slight malaise.—This eruption commences with redness of the affected parts; then small collections of purulent matter from irregular-shaped patches, more or less confluent, resting upon surfaces of a coppery-red colour, which are soon covered by scabs irregular in shape, harder, darker coloured, and more adherent than those of non-syphilitic impetigo. Beneath these scabs are ulcerations, followed by scars, varying in shape and extent. This eruption more frequently occurs on the face, but it may affect any part of the surface. It sometimes appears on several parts simultaneously, but it has no tendency to spread. It is always secondary.

(*c.*) *Ecthyma.*—The pustules are still larger,—the size of a shilling, or more isolated, and few in number; chiefly occurring on the limbs, and especially the legs. Commencing as large livid spots, the epidermis becomes raised over a considerable portion of each spot, by a greyish, sero-purulent matter, which increases slowly, and is always surrounded by a broad copper-coloured areola, unlike the violet-red of non-syphilitic ecthyma. After a few days, the pustules having broken, scabs form, which are of a circular shape, dark and hard; gradually increasing in thickness they fissure at their edges, and are very adherent and persistent. On separating, they expose deep round ulcers, with sharp-cut hard margins of a purple colour, whilst the bottom is greyish. They have little tendency to enlarge. The scabs generally re-form, and repeatedly, until the ulcers heal; leaving circular and lasting cicatrices.

This is the most common species of syphilitic pustular eruption, and that which is usually met with in new-born children. Here, the pustules are broad, superficial, flat, of an oval shape, and in great numbers; the scabs are dark and thick, and conceal small ulcers underneath. The countenance of the patient has quite a peculiar appearance; it is drawn in, and marked with numerous wrinkles, like that of an old person; the skin has an earthy hue, the body is emaciated, and exhales a most disagreeable odour.

Ulceration of the Skin in constitutional syphilis, may be either a sequel of some kind of eruption, or it may arise independently; the syphilitic blood-disease always predisposing to disintegration of texture. But the characters of any such ulcer can scarcely be regarded as peculiar to syphilis. Ulceration of the skin in connection with disease of bone about the skull, is specially noticed by Mr. Lee, with reference to its apparent cause—irritation—rather than as arising from the direct influence of the syphilitic poison. The importance of this diagnosis, in relation to the appropriate treatment, is obvious.

(2.) *Diseases of Mucous Membranes.*—*Ulceration of the tonsils*—"sore throat"—ranks among the earlier and less equivocal secondary symptoms.

The ulcer formed is excavated, with a sharp and prominent, not to say everted, margin. The bed of this ulcer is sloughy, the surrounding mucous membrane dusky red. But even these appearances are not distinctive of syphilis, and original observers, such as Rose and Carmichael, concur in mistrusting "the ulcerated sore throat." Certainly, the excavated ulcer of Hunter is not consequent on the indurated chancre only; and we must acknowledge, with Carmichael, that affections of the throat are too indistinct to afford any certain diagnosis.

Fissures of, and *milky stains* on, the tongue and inside the lips are more pathognomonic, but the former must be distinguished from those cracks which accompany irritable dyspepsia, and the latter—opaque white spots—resemble aphthous spots.

More doubtful are *mucous tubercles* situated on various parts of the buccal mucous membrane, as the tongue, lips, palate, and tonsils. These tubercles are of a whitish colour, and may be seen also on the skin, in the form of pale, soft little cushions, bedewed with mucus; the skin surrounding each tubercle appearing puckered around its margin. Such tubercles—condylomata—are commonly found in secondary syphilis, grouped around the anus or on the scrotum; also, fretting along the margin of the external labia in the female; perhaps on the perineum, inner aspect of the thighs, and on the groins. Sometimes these tubercles occur in the axillæ (E. Wilson); and, in fact, wherever ordinary tubercles are warm and moist, they frequently become mucous tubercles, skin readily assuming the appearance of mucous membrane.

But mucous tubercles are not necessarily syphilitic. Wilson notices the transition of roseola into lichen, of the roseola eruption into such tubercles, and that the conversion of lichen into them is by no means uncommon; yet roseola and lichen are not necessarily syphilitic eruptions.

Ulceration of the *nasal* mucous membrane, that of the hard and soft *palate*, of the *pharynx* opposite the mouth, and of the *larynx*, is liable to occur in secondary syphilis. These ulcerations are frequently accompanied with caries of the nasal bones, of the hard palate, even of the vertebræ behind the pharynx, and necrosis of the laryngeal cartilages. The breath and discharges are singularly fœtid. Is any such ulceration peculiar to secondary syphilis? Colles acknowledges his inability to determine whether an ulcer in the nose be venereal or not. The appearances of scrofulous ozæna closely resemble those of venereal ozæna. Colles describes an ulcerated opening situated on the septum nasi, about a quarter of an inch from its anterior extremity, this ulcer being uniformly circular, and as large as the surface of a split pea; but he adds that a similar aperture may be found in persons who certainly never had any venereal affection, and that it may remain for years, at least for eight or ten years, in cases under observation. Extensive ulceration of the pharynx, as well as ulceration of the nasal mucous membrane and caries of the nasal bones, were noticed by Carmichael to be frequently associated with the primary phagedænic ulcer, but that similar ulceration of the pharynx arises in constitutional conditions assuredly not venereal. *Chronic laryngitis*, and ulceration

of the rima glottidis, denoted by a broken voice, impulsive cough and foul expectoration, may be a manifestation of advanced and grave secondary syphilis. Portions of the laryngeal cartilages—*e.g.*, the cornua of the thyroid cartilage, in an ossified state—are occasionally coughed up. But syphilitic laryngitis presents nothing peculiar in its characters, from first to last, whereby it can be distinguished from chronic laryngitis under other circumstances. The symptoms just mentioned might follow laryngitis, from a common cold.

(3.) *Syphilitic iritis* was overlooked by Hunter, in his observations of the course of the venereal disease; but although iritis is undoubtedly a frequent form of secondary syphilis, it cannot be distinguished from arthritic iritis; and resembles scrofulous iritis, in so far as regards the appearance of the eye itself. "Although," observes Lawrence, "the effusion of reddish, brownish, or brownish-yellow lymph on the iris in the adult, clearly shows the case to be venereal, I have seen analogous appearances in several instances, both of young children and infants, in whom no suspicion of syphilis could be entertained." The symptom in question is not peculiar to syphilitic iritis. Nor is "displacement of the pupil upwards and inwards" a characteristic appearance. It has been seen, especially by Mackenzie, in chronic rheumatic arthritis; and still more frequently in scrofulous sclerotitis, without iritis. Moreover, it is present only occasionally in syphilitic iritis. This symptom, therefore, is inconstant as well as equivocal. Mackenzie mistrusts all the special symptoms accorded to syphilitic iritis, excepting the *tawny* or *rusty colour* of the iris near its pupillary edge, a condition present in most syphilitic cases, and almost exclusively in them alone.

(4.) *Chronic enlargement of the testicle* occurs late, if at all, in the course of syphilis, and cannot be distinguished from scrofulous enlargement of this organ. The physical characters which the testis assumes in these two diseased conditions are very similar. In both cases, the enlargement may commence in the epididymis—sometimes in syphilitic, generally in scrofulous disease. In both cases, this swelling subsequently engages portions of the testis itself, the intervening portions remaining free and healthy; so that sometimes, by careful manipulation, *nodules* can be felt in the substance of the organ, through the tunica albuginea. At length the whole testicle becomes considerably enlarged, and feels hard and heavy. Then the scrotum may become inflamed and adherent, eventually undergoing ulceration, accompanied with protrusion of the testicle. In one such case, having excised the organ, on section, the appearances were those of a scrofulous testis. The epididymis was filled with a yellow friable matter, which, under the microscope, was seen to consist of imperfect broken cells and granules; while nodules of this substance were deposited here and there throughout the testicle, itself otherwise healthy, the reddish-grey colour of its tubuli seminiferi contrasting with the yellow nodules. The man bore the mark as of a chancre at the corona glandis, which he says occurred about two years ago, and that the testicle began to enlarge nine months prior to the operation. Judging merely from the condition of the organ itself, in this case, it would have been almost impossible to have pronounced its enlargement syphilitic; and, indeed, the most accurate diagnosticians have acknowledged the resemblance of scrofulous and syphilitic disease of the testicle. Under whatever

circumstances chronic enlargement of the testis takes place, the symptoms are precisely the same, observes Sir B. Brodie. Dupuytren, also, was led to this conclusion by his observations.

Simple *glandular* enlargement or hypertrophy, and atrophy, of the testicle, are also noticed by some authors.

The *absorbent glands*, in various parts of the body, are liable to become enlarged, and their indurated enlargement, especially on the occiput and back of the neck, is regarded by Ricord, I believe, as diagnostic of secondary syphilis. But this condition is attributed, by other writers, only to disease of the parts in communication with such glands.

(5.) *Diseases of the bones, periosteum, fasciæ, and ligaments* are possible manifestations of constitutional syphilis, advancing from the surface to deeper textures within the body; but this is a neutral ground, shared by the mercurial poison—prolonged mercurialization, by scrofula also, and by rheumatism. The question of venereal origin is open, therefore, in every case, to investigation, probably afterwards to doubt.

A truly syphilitic *node*, for example, is usually considered to signify merely chronic enlargement of the bone itself. A hard swelling forms, without any redness of the skin in the first instance, nor for some time; eventually it becomes red and acutely painful. The syphilitic virus appears to select certain bones or portions of bones for the production of nodes; they are mostly subcutaneous, as the inner aspect of the shaft of the tibia, the subcutaneous portion of the ulna, the sternum, clavicle, and cranium; rarely also, I have found the seat of election to be the humerus, just above the inner condyle, or the crest of the ilium. These portions of bone more especially form nodes, which become inflamed. Nodes arising from periostitis are softer, and evidently inflamed from their commencement. They are also more acute.

These distinctions are true, and yet the hard chronic node is no criterion of secondary syphilis. This kind of node seldom, if ever, appears, excepting when mercury has been used, and coming, as it does, late in the career of syphilis, has perhaps been preceded by more than one salivation. Issuing from the mixture of mercury and syphilis, one cannot say how far a chronic node is due to one or the other. Carmichael's experience led him to regard this symptom as "equivocal and uncertain." Colles notices "a general nodose affection of the bones," which is liable to be confounded with so-called syphilitic nodes.

Caries and *necrosis* are no less doubtful evidence of constitutional syphilis. Spongy softening of the bones, denoting caries, may happen in an advanced stage of secondary syphilis, and has its chosen seats; these being chiefly those where nodes are prone to form—on the tibia, ulna, clavicle, sternum, and, above all, the nasal bones and cranium. But whatever bone or bones undergo carious softening, there is nothing characteristic of syphilis. Mercury as well as syphilis may be at work; and indeed we rarely, if ever, find caries in syphilitic cases, excepting where mercury has been freely used. None of the cases of syphilis which came under the observation of Guthrie, in the York Hospital, were accompanied with caries; and such was also the experience of Rose, in his series of cases, upwards of 120 in number, and where he was able to ascertain that the patients remained free from syphilis for

many months afterwards, or if secondary symptoms returned, caries was not one of them. Necrosis, in constitutional syphilis, is equally often the offspring of mercury.

Tertiary Symptoms.—All the foregoing diseases can scarcely be designated secondary. Some of them, and more particularly disease of the testicle and of the bones, are *tertiary*, as compared with others previously described in the series. So also are certain ulcerations affecting the *nose*, *lips*, and roots of the *nails.*

A tubercular nodule may form on the ala of the nose. It is a hardened copper-coloured mass, varying in size from the eighth of an inch and more; persistent perhaps for many months, then ulcerating and destroying the nasal cartilages, and possibly extending further.

Cracks on either lip may appear, and remaining for weeks or months, ulcerate extensively.

Ulceration about the roots of the nails, onychia, may occur, having a brown or black colour, surrounded by a deep copper-red margin, and attended with a most offensive discharge. The fingers, toes, or both, though commonly the former, may be thus affected. In either case the ulceration is very obstinate, and the nails loosen, or fall off.

The *hair* may become dry, withered, and faded in colour; cracked or split at its extremities, and be shed or easily combed off, abundantly, even to baldness. If the bulbs are affected, the hair is not reproduced, and the baldness is permanent, a condition known as *alopecia.* It may be partial or entire; and affect the beard, eyebrows, and eyelashes. In one case, recorded by Vidal, the hair over the whole body came off.

Gummy Tumours are met with, consisting of degenerative transformations of connective tissue, and having a yellowish-white appearance on section; of variable size, but with an ill-defined outline, being perhaps thinly encapsuled, yet continuous with adjoining textures. The consistence of these tumours is tolerably distinctive—hence named gummy; they yield a soft or firmer resistance to the touch, or having undergone atrophy and conversion into caseous matter, the little mass becomes a harder lump. The parts in which such tumours may be found are very widespread:—in the skin or mucous membrane, or seated in the sub-cellular tissue, and at length forming tertiary ulcers, as on the tongue or soft palate, or in the pharynx and larynx; in fibrous membranes, as the periosteum, or in bones, appearing as nodes; while, in the connective tissue of muscles, gummy tumours are not uncommon, as obscure growths; and in organs, more particularly in the liver, lungs, spleen, brain and nerves, kidney and testicle, these formations constitute the syphilitic affections of internal organs which have specially been investigated by Lancereaux and Dr. Wilks.

Lastly, a wan, yellowish hue overshadows the skin in an advanced stage of the disease, which is designated the syphilitic *cachexia;* but this may denote a mercurial deterioration of the blood.

Congenital, Hereditary, or Infantile Syphilis.—The term infantile syphilis is not intended to signify primary syphilis in an infant, communicated at birth, from a primary sore or chancre existing in the person of the mother. The disease referred to is truly constitutional syphilis inborn, and transmitted as an hereditary infection, from the mother at the time of conception or during the period of intra-uterine life. But constitutional syphilis in the mother, in the father, or in both

parents, is not necessarily transmitted to the offspring; who may indeed be singularly free from any manifest constitutional syphilitic taint, or any other evidence of impaired constitutional vigour—as scrofula.

Syphilitic infection of the *ovum* appears so to lower its vitality, as to entail many morbid consequences. Abortion may ensue, at a variable period of pregnancy, the ovum never reaching maturity. Several consecutive miscarriages may thus take place, until the maternal or paternal state of infection is rectified or eradicated; when the mother will probably retain the fœtus for the full period of pregnancy—nine months, and then give birth to a living child. From the time of birth, the infant may exhibit symptoms of secondary syphilis, and present a cachectic, weakly, dwindled, and as it were, aged appearance. Or, free from any secondary symptoms at birth, they supervene in a variable period—a few weeks, commonly between the second and eighth week—or, possibly, not until adult age. But after the eighth month, Trousseau affirms that the disease very rarely appears.

The *mode of communication* would appear to take place in either of four ways, or in their combinations:—(1) From constitutional syphilis in the father, and without communicating any apparent infection to the mother; (2) from constitutional syphilis in the mother; (3) from both parents; (4) from systemic infection of the mother, through a primary sore—a chancre contracted during pregnancy—the embryo having been quite healthy at the time of conception. And the liability of the fœtus to infection is much greater during the earlier period of pregnancy than in the later months; an analysis of eleven cases by Diday tending to the conclusion that, after the end of the seventh month, syphilis acquired by the mother is not transmitted to the offspring. But neither parent may exhibit any symptoms of syphilis, the disease having been latent for perhaps a period of many years. (Bumstead.)

The important relation of these modes of transmitting syphilis to offspring will be obvious, both in regard to treatment and to medicolegal inquiry.

Many other questions pertaining to hereditary syphilis remain open to doubt, and are disputed. *Firstly*, whether a mother, pregnant with a syphilitic fœtus, the offspring of a father having the constitutional disease, can be infected through it without herself having had primary syphilis? Ricord answers this question in the affirmative, and the possibility of this mode of maternal infection, is supported by a large amount of evidence collected by Mr. J. Hutchinson. *Secondly*, whether a wet-nurse, having the constitutional disease, can infect the child she suckles, through the medium of the milk? Yes, says Ricord; no, says Acton. *Thirdly*, conversely, whether a syphilitic child can infect a healthy nurse? No, say Ricord and Acton. But Hunter and Lawrence relate cases in which several nurses have been thus infected, in succession; and two of whom transmitted the disease again to their own offspring. Evidence in support of the affirmative of both the two latter questions, may be found in "Ranking's Half-yearly Abstract," vol. iv. As to the mode of communication by suckling; any crack or abrasion on the nipple, or on the lip or mouth of the child, will facilitate the transmission. But, according to Dr. Colles, mere contact, without any excoriation, will suffice.

Symptoms.—Congenital syphilis is not indicated by any constant

and peculiar symptoms taken singly, but collectively they are diagnostic. The order of development is uncertain. The cachectic, wasted, and withered condition of the child usually attracts attention. The face has a muddy tint, or there is a tawny-coloured patch in the place of either eyebrow, from which the hair has fallen; the skin is loose and wrinkled, especially around the eyes, mouth, and nose, which also has a flattened appearance; and the expression is remarkably old-looking, giving to the visage of the infant a monkey-like aspect. The voice or cry is cracked, like the sound of a penny trumpet, as Dr. Farre observes. Secondary symptoms are manifested by the skin, and mucous membranes—especially of the nose and mouth. Congestion of, and offensive muco-purulent discharge from the *nasal* mucous membrane, are accompanied with a puffed appearance of the nose, and constant snuffling breathing, as a chronic catarrh, existing from birth, or soon supervening. The *mouth* may exhibit around the lips radiating cracks or fissures, with spots of ulceration, and milk-white patches may be found on the palate. *Cutaneous eruptions* appear, before birth—the infant presenting some such eruption from birth, or not until some weeks have elapsed—usually three or four. Certain parts are affected more particularly; the mouth and anus, the nates or scrotum, the palms of the hands and the soles of the feet. Hence, observation should always be directed to these parts, in examining an infant supposed to be the victim of hereditary syphilis. The congenital eruption may be recognized in the form either of mucous patches, of a spongy, oozing character, especially besetting the angles of the mouth and perhaps the fauces, or gathered around the anus; elsewhere the eruption may be that of roseolous spots, which come and go; or the cracked appearance of psoriasis may be presented, more especially in the inelastic skin of the palm of the hand and sole of the foot; sometimes the eruption takes the form of flat, squamous tubercles; or vesicles or bullæ, known as pemphigus, which dry into scales or scabs. A brownish-red, coppery colour, of or around these eruptions, is more characteristic. Iritis is not uncommon; this affection occurring in about five or six months after birth, and being attended with an abundant effusion of lymph, occluding the pupil so that the sight is generally lost. Interstitial corneitis usually appears, but at a later period,—between the eighth and fifteenth years. Syphilitic periostitis and caries are comparatively rare; but sometimes the bones lose their epiphysial connections. The *teeth*, both temporary and permanent, are affected in the tertiary or later form of congenital syphilis. According to Mr. J. Hutchinson's original observations, certain carious or ill-developed appearances are presented. The *temporary* teeth are cut early, have a bad colour, and are liable to a crumbling decay. The upper central incisors usually undergo this destructive change early, and always first; then follow the lateral incisors, which become carious and are shed; lastly, though rarely, the canine teeth wear away, so as to assume a flattened, tusk-like character. (Fig. 78.) The teeth represented are the upper set of a syphilitic child, aged nearly three years. Owing to early decay of the incisors, the syphilitic child remains edentulous from an early period, in regard to these teeth, and has a

Fig. 78.

remarkably unsightly appearance in the laugh of childhood, until the permanent ones are cut. The *permanent* teeth are more peculiarly affected; chiefly the upper incisors, and first the central ones. They are discoloured, short, peggy, rounded at the angles, standing apart with interspaces, or converging; and marked, on their margin, with a deep broad notch. (Fig. 79, showing two upper and four lower permanent incisors, recently cut, in a girl, the subject of inherited syphilis.) They readily disintegrate, crumble, and wear down.

Fig. 79.

After the period of infancy, the individual peculiarities of physiognomy and appearance of the skin, by which the subject of inherited taint may be recognized, are, as Mr. Hutchinson observes, the consequences of specific inflammations which the patient has undergone at former periods; *e.g.*, the synechiæ and lustreless iris of iritis, the malformed teeth of periostitis of the alveolus and dental sacs, the protuberant forehead of hydrocephalus, the flattened nose of snuffles, the pale, earthy, opaque skin of cutaneous eruptions. If in infancy the child escapes some such inflammatory affections, their consequent peculiarities of appearance will be wanting in the picture of after-years. Growth and development are often arrested. As some compensation to the innocent victim of this inherited disease, it is probable that he enjoys some protected immunity to fresh syphilitic infection, or that the acquired disease would then have a milder character in a constitution which has once paid the penalty.

The *prognosis* of congenital syphilis may be determined mainly by the more or less early supervention of the symptoms of the disease. A withered tawny-faced infant at birth, and affected with snuffling and nasal discharge in the course of a day or two, will probably die. The difficulty of suckling such an infant,—for the act of sucking is imperfectly performed, the supply of milk from the diseased mother may be poor and scanty, and the substitution of a healthy wet-nurse would be obviously improper—the difficulty of weaning the infant to food suitable to its weak digestion and assimilation, and the oppressed respiration under which the child labours, are all very unfavourable to the renovation of nutrition and ultimate recovery. Whereas, when the infant remains free of syphilitic manifestations after birth for a period of two months or longer, and is then affected with symptoms,—when the syphilis is hereditary rather than congenital, it is probable that nutrition will have become sufficiently established for the child to outlive the disease, and perhaps also the liability to its return.

But the *mortality* from congenital syphilis is far higher than that from the acquired disease. Bassereau is led to believe that in at least one-third of the congenital cases, death ensues within a few months after birth. *Post-mortem* examination discloses morbid conditions of certain internal organs, more especially; which, however, do not seem to possess any special practical importance. They comprise chiefly the appearances of broncho-pneumonia—death having often resulted from this pulmonary affection; indurated deposits in the lungs, of a yellow colour and elastic consistence, which are probably gummy tumours,—the small cells found in these deposits being characteristic, and different from those of tubercle and cancer; a degenerate and

softened state of such tumours may present the appearance of purulent infiltration or abscesses in the lungs; a so-called suppuration of the thymus gland, often found after death, is probably of a similar nature; syphilitic peritonitis has been noticed by Sir James Simpson; and lastly, the albuminoid liver, a degeneration of very common occurrence in congenital syphilis. First noticed by Gubler (1848), and afterwards minutely described by Diday, this albuminoid degeneration may be recognized—as Sir William Jenner observes—by certain characters; the liver is large, smooth, hard, heavy, pale, and semi-transparent, and infiltrated with a matter something like glue.

The *Treatment* of Congenital Syphilis will be mentioned in connection with the general Treatment of Syphilis.

VACCINO-SYPHILITIC INOCULATION.—A most important social question is, whether a true chancre—an infecting syphilitic sore—can be communicated by vaccination, through the vaccine virus? Dr. Viennois, in 1860, brought forward cases, apparently, of such syphilitic transmission; other cases subsequently occurred under M. Trousseau, in the Hotel Dieu; and, since, at Rivalta, an overwhelming demonstration occurred, one child, thus infected, having re-transmitted the disease to another child, and thence, through both, to forty-five other children, and to twenty other mothers or nurses! In this country, the observations of Mr. Thomas Smith and of Mr. Jonathan Hutchinson have since borne corroborative testimony as to the possibility of vaccino-syphilis.

DIAGNOSIS OF CONSTITUTIONAL SYPHILIS.—The presence of constitutional syphilis, as manifested by secondary symptoms, is determined solely by the calculation of *probabilities;* and this is the basis of diagnosis in respect to *all* diseases, excepting the few that are absolutely determined by pathognomonic signs. The diagnostic value of any one symptom is represented by the constancy of its presence and association with the same disease, and by the early period of its occurrence.

But the *co-existence*, or at least the *consecutiveness*, of symptoms, any one of which is equivocal, *per se*, constitutes a weight of evidence greater in the *aggregate*, than that which the *several items* of evidence would represent by being merely added together.

To illustrate this force of concurrence, by the evidence of secondary symptoms, I shall pass over the order of priority of these symptoms; thus overlooking the relative value of each, as an early symptom. No one secondary symptom is sufficiently constant or peculiar to syphilis, to make their *order* of succession a question of much practical interest. But the fact of these symptoms being concurrent in the same person, outweighs their inconstancy. Let the weight of *anti*-syphilitic probability be represented by 5; then any one of the five usual secondary symptoms may be absent, or, if present, may point perhaps to constitutional syphilis, perhaps to the mercurial crasis, perhaps to both; perhaps to neither of these blood-diseases, but proceed from other causes. Thus, the skin-eruption having a coppery hue; the excavated ulcer of either or both tonsils; iritis; enlarged testicle; node, caries, necrosis; are *severally equivocal* symptoms of constitutional syphilis; but taken *collectively*, or at least as *consecutive* symptoms, they *outweigh* the supposed anti-syphilitic counterpoise. Constitutional syphilis is diagnosed by an overbalance of probabilities in its favour—this overbalance being due, not to the actual diagnostic value of each symptom or probability,

but to their concurrence. In like manner, other circumstances may tend to corroborate our diagnosis. The fact of primary syphilis, present or antecedent, has its weight—the weight of an additional probability, concurring. We look for the remains of a presumed chancre or chancres, and probably, also, the vestiges of a bubo or buboes.

The diagnosis of constitutional syphilis—thus clearly illustrating the diagnostic value of concurrent symptoms—is the species of evidence on which rests the diagnosis of most other blood-diseases; and, indeed, of diseases generally, the evidence of which is *symptomatic.*

Blood-pathology of Syphilis.—Syphilis, secondary or constitutional, so-called, is essentially a blood-disease; the evidence being, partly, the "number of textures" affected with some form of mal-nutrition—as of the skin, mucous membrane, iris, periosteum, bone and testicle; partly, the "migratory" character of these local affections—from skin to mucous membrane, to the iris, thence to the testicle, or to periosteum and bone; and partly, the "symmetrical" character of some such local affections; occasionally, also, their "serpiginous," or creeping nature, as phagedænic ulcerations of syphilitic origin. But the last two characters would seem to indicate some determining power in the *textures*, respecting the particular locality and form in which a particular blood-disease shall manifest itself. Lastly, syphilis is capable of being propagated by "inoculation," thereby introducing the *materies morbi* into the blood.

The blood-pathology of syphilis shares the obscurity of other blood-diseases with few exceptions. The microscope exhibits nothing remarkable; chemical analysis, at present, brings nothing to light. The potent virus works unseen, being known only by the commotion it occasions. As when a diver has disappeared beneath the surface, we watch the troubled waters, without seeing his operations in the deep; so likewise the syphilitic virus having dived into the blood, we know nothing of its doings there, only that it throws up some eruption on the skin or mucous membrane. Moreover, as the *débris* and bubbles thrown up by a diver cannot be distinguished from the commotion produced by some monster sporting in the deep; so also the scales and pustules of syphilis are subsequent and equivocal signs of the kind of poison at work. But the virus has not hitherto been detected in the blood; nor does inoculation with syphilitic blood manifest any characteristic results. Ricord failed to discover inoculable pus in the blood, even in veins nearest the chancre. MM. Ricord and Grassi first noticed "a decrease of the globular element in the blood of persons affected with syphilis arising from the simple or non-infecting chancre;" and indurated chancre also is apparently followed by a diminished proportion of globules, while the albumen increases.

Causative relation of Local to Constitutional Syphilis; and the Unity or Duality of the Syphilitic Virus.—Of the two forms of Local Syphilis which have been designated Chancres, opinions differ respecting their causative relation to Constitutional Syphilis. It would be impossible within the limits of this part of the work, to discuss the evidence and arguments pertaining to this vexed question.

Ricord and his school maintain that only one form of local syphilis —the *indurated* chancre—is the source of systemic infection, that it is *the* infecting sore, and that it invariably produces constitutional syphilis; but that the non-indurated or soft chancre is always a

local disease, and never followed by secondary affections. Hence, indurated chancre is the *only* form of *primary* syphilis; and, indeed, that the supervention of induration is the first manifestation of systemic infection—the first secondary symptom. According to other authors, the term syphilis signifies an entirely constitutional disease, not to be distinguished as primary and secondary; the term chancre being restricted to the initial local lesion of syphilis, whereby the virus is introduced or inoculated. If therefore, indurated chancre be the only species of ulcer which is followed by syphilis, it thus differs essentially from soft chancre; the one being the only form of local, or primary, syphilis; the other, distinctively named chancroid, being only a local contagious ulcer of venereal origin. Hence the *Dualist* theory, in regard to the production of these two diseases. First proposed by Bassereau (1858), a former pupil of Ricord's, this theory has been advocated by several eminent supporters; Rollet, Cullerier, Bumstead, H. Lee, and others, and is still gaining adherents. But Dualists strenuously maintain the unity of the *syphilitic* virus.

On the other hand, some observers, scarcely less distinguished, maintain that while the indurated chancre possesses the greater power of producing constitutional syphilis, and is thus the most frequent cause, yet that *soft* chancre—chancroid—may also, occasionally, have this relation. Hence, that chancroid may be regarded as a form of local, or primary, syphilis. This is known as the *Unicist* theory; or the reference of these apparently different diseases to one common causative origin. Velpeau, Devergie, and Casenave, more prominently represent the school of Unicists.

My own experience inclines to the latter view of the relative infecting character of hard and soft chancres, and thence to Unicism.

Inoculation throws some light on this question. The general results of inoculation in regard to syphilis, may perhaps be stated as follows:—

(1.) That a chancre always produces a specific virus.

(2.) That all chancres—hard and soft—are capable of being propagated by inoculation.

(3.) That inoculation with the serum or lymph from an indurated sore will only produce a chancre, and that an indurated one, when the system is unaffected. During, therefore, only the earliest stage of such chancre—*i.e.*, prior to induration, which may be regarded as the first secondary symptom.

(4.) That inoculation from an indurated sore—the system being unaffected—is invariably followed by secondary affections.

(5.) That inoculation from a soft chancre is less certainly productive of secondary affections.

(6.) Secondary syphilis may be propagated by inoculation.

(7.) But, that inoculation from secondary syphilis is inoperative on the individual himself, or upon another individual having secondary syphilis.

(8.) That the secretion of other specific diseases existing in syphilitic subjects (including the specific syphilitic pustule, and the sores which result from it), has no power of imparting constitutional syphilis. (H. Lee.)

(9.) That the natural secretions of glands in syphilitic subjects, when those glands are not themselves specifically diseased, have no power of imparting constitutional syphilis. (H. Lee.)

If any of these propositions be erroneous, the error arises not simply from the difficulty inherent in the investigation of inoculation, but also from the difficulty of rightly estimating the mass of, apparently, contradictory evidence on this subject.

The *modus operandi* of chancre in producing systemic infection, is doubtful.

The *lymphatic* or absorbent vessels were formerly regarded by Hunter, and his school, as the only medium of transmitting the syphilitic virus. Independently of the experimental facts adduced by Ségalas and Magendie, in evidence of the *veins* also being absorbents, there are two general facts which, apparently, disprove the absorbent function of the lymphatics, in the production of syphilitic systemic infection. (1.) That in those cases in which the irritation of the lymphatics is greatest, and where, therefore, we have the best evidence that the morbid matter has entered them, there is very seldom any secondary syphilitic affection. (2.) That the best-marked cases of systemic infection are as rarely preceded by any very evident signs of inflammation of the lymphatic glands. In the first class of cases, moreover, the progress of the syphilitic virus may be traced along the lymphatic vessels as far as the first lymphatic glands in their course, but never beyond. In any part of this course, the poison may be arrested and produce a hard knotted cord or round induration, or even a fresh chancre; but there is no proof that the virus is conveyed unchanged through these glands; on the contrary, the vessels beyond are never affected, and bubo never forms in the glands next in order. Thus, chancre on the penis or vulva induces bubo of the gland in the groin, above Poupart's ligament, but does not affect the vessels and glands within the abdomen; chancre on the finger affects the gland on the inner side of the biceps muscle just above the elbow, but not the axillary glands.

Duly weighing these facts, and the analogy of the syphilitic virus with other poisons, in producing systemic infection, Mr. Lee is inclined to believe that the syphilitic virus is communicated *directly* to the blood, through the nutritive changes of the part around a chancre, or point of inoculation.

TREATMENT.—*Primary* and *Local Venereal Ulcers.*—The first consideration in the treatment of syphilis is the question of the *prevention* of systemic infection. (1.) *Chancre.*—The early destruction of chancre, within the first four days after contagion, and thence the prevention of systemic infection, was known as the *abortive* treatment of syphilis; that primary syphilis being thus anticipated, the secondary or constitutional form of the disease would not follow. Accordingly, cauterization and excision of the chancre have both been advocated and practised; the former preventive measure especially, by Ricord and Sigmund of Vienna, and reported to have proved successful, for the prevention of infection, in some thousands of cases. But, considering the long period of incubation of the syphilitic virus,—two to three weeks as the average time, from the very beginning of which absorption must have proceeded—and the fact also, that when chancre is produced, the system has already become infected, it will be obvious that any local treatment which shall be preventive or abortive of syphilis must be extremely improbable or even impossible. Destructive cauterization has proved unsuccessful during the incubatory

period,—as early as four or five days after the sexual intercourse; and, as applied within only a few hours after the development of chancre, it has failed to avert the constitutional disease. In a case by Diday, the chancre having appeared a month after intercourse, abortive treatment was tried within six hours; the sore healed in three days, yet secondary symptoms supervened in three weeks. The reputed efficacy of abortive treatment, relative to chancre, is also denied by Professor Bumstead and Mr. H. Lee, and it is now generally discredited. Former cases of supposed success were probably those of the locally contagious, soft suppurating ulcer.

(2.) *Chancroid, the Local Contagious Ulcer.*—The period for the production of this ulcer after contagion is of short duration; from two to four days, or within a week. Preventive cauterization must, therefore, be had recourse to within that time. Subsequently, however, the same treatment is available to prevent the propagation of chancroid; and for the destruction of bubo, which becoming a suppurating ulcer, has the same contagious character.

Cauterization, to be effective, must be, not a slight superficial application, which only destroys the surface of the ulcer, but cauterization, deep, broad, and destructive. We are dealing not merely with a poisoned wound, but a reproductive poisoned wound. The *escharotics* most reliable are therefore the mineral acids, sulphuric and nitric, chloride of zinc, potash and lime combined in the form of Vienna paste, pernitrate of mercury, and the actual cautery. Nitrate of silver has the dangerous reputation of being sufficiently caustic, because some chancroid sores heal after its application. Of the other agents, sulphuric acid, mixed with finely powered charcoal—the carbo-sulphuric paste, as originally employed by Ricord—is a very effectual caustic. Chloride of zinc and flour, in equal parts, forming Canquoin's paste, is also very serviceable, and was first advocated by Rollett and Diday. Either of these caustics may be used with a glass-rod, or a glazed crockery spatula. The caustic must be applied over the whole sore and around, so as to include the infested peripheral zone of tissue beyond it. The effect of cauterization should be limited within due bounds, if necessary, by means of some antidote; as a solution of carbonate of potash, after an acid caustic, or an acid, such as vinegar, to restrain an alkaline caustic. But the caustic or paste may be left on the ulcer, where with the slough it forms an adherent scab, and the sore heals underneath. Or, where a caustic paste has done its work, in a period of about two hours, it may then be removed, and water-dressing or dry lint substituted, the latter being preferable; thus simply to protect the surface from the risk of contact with any adjoining chancroidal ulcer.

Destructive cauterization is *impracticable*, observes Professor Bumstead, when the chancroid cannot be fully exposed; as in consequence of phimosis, or concealment within the urethra, os uteri, or other inaccessible situations. It is *inadmissible* with regard to ulcers situated directly over the urethra, either in the male or female, owing to the risk of opening this passage; so also in chancroids of the deeper portions of the vagina, where the walls are in contact with the bladder, rectum, or peritoneum; in sores upon the margin of the urinary meatus, lest cicatricial structure should result; lastly, wherever the presence of other ulcers in the neighbourhood, which cannot be sub-

jected to the same treatment, would thus expose the surface, after separation of the eschar, to re-inoculation, as in the case of chancroid upon the margin of the prepuce, with phimosis concealing a chancroid within.

Excision is rarely so successful as cauterization. Even when performed freely enough to insure extirpation, and with the precaution of removing any contagious matter, the wound is liable to become re-inoculated, forming a larger contagious sore than the original one. Hence, removal with the scissors or knife is eligible only in certain parts; as in the case of chancroids fretting the margin of the prepuce or the border of the labiæ of the vulva, where the instrument can be carried sufficiently wide of the ulcers. The fresh surface should then be touched with caustic, to form a protective eschar.

Phimosis, complicating sub-preputial chancre or chancroid, may be a congenital malformation, or acquired by induration or inflammatory engorgement. Destructive cauterization can be of no use, when *chancre*, thus enclosed, has become indurated, systemic infection having already taken place; and with *chancroid*, the phimosis being of an inflammatory character, any such treatment might induce gangrene. But the part should be regularly cleansed, by syringing the prepuce with tepid water, or with a weak astringent solution, as the nitrate of silver, five or ten grains to the ounce. The operation for phimosis—that of slitting up the prepuce—in order to make any direct application to the chancroid, would be an improper procedure, from the liability of thus converting the wound into a larger chancroid ulcer, cases of which have happened.

It will be observed that the abortive treatment of chancroid, chancre not being thus controllable, has regard not only to the *individual* affected; it is also the surest preventive measure, *socially* considered, by extinguishing the source of contagion.

As a public preventive measure against the propagation of primary syphilitic infection, the "Contagious Diseases Act" for the periodic inspection of different classes of the community, was recently instituted;—a similar legislative enactment to that which is in operation in France. As might be anticipated with reference to a procedure of such nature, its expediency has been strenuously advocated from a sanitary point of view, and an extension of the Act urged, by numerous scientific supporters; and it has been equally denounced, on moral and social grounds, by irreconcilable opponents. The Government has wisely declared its intention of abiding the result of the most complete inquiry.

The *curative* local treatment of *chancre*, as a specific sore, is best accomplished by mercury. It may be applied in the form of mercurial ointment, spread on lint, and laid on the sore; or as a lotion—the lotio nigra, consisting of calomel and lime water, in the proportions of ℈i. to ℥vi.; or, by calomel fumigation, locally applied, as suggested by Mr. Lee. Five or ten grains of calomel may be volatilized over an ordinary fumigating lamp, and the ulcerated part should then be held directly over the vapour, until the white powder is fully deposited on the sore, where it must be allowed to remain.

Chancroid having been destroyed by free cauterization, it becomes a simple healing ulcer, which needs only the protection of water-dressing. Various lotions, of a stimulant or astringent character,

may, however, sometimes be used with advantage; as the diluted nitric acid, ʒi. to ℥viii. of water, or a weak solution of sulphate of copper, grs.v. to ℥i.; tannic acid, ℈i. to ℥vi., is another good formula, or perhaps the aromatic wine, ℥i. to ℥iii. of diluent, as employed by French surgeons; while nitrate of silver, grs.xv. to ℥i., is much recommended by Rollet. Disinfectant and cleansing washes may be substituted, as occasion requires; a chlorinated solution, ʒi. to ℥ii. of water; or a solution of carbolic acid, ʒii. to Oi., which Professor Bumstead prefers.

The *various forms* of ulceration which both chancre and chancroid may assume, as already noticed, will require modifications of treatment accordingly. Thus, the inflamed and the irritable sores are to be treated by the same measures which would be appropriate for similar ulcers otherwise arising.

Inflamed and *suppurating indurated chancre* is a rare variety, but an *inflamed* and *indurated chancroid*—the *phlegmonoid* form, so named by Ricord—is not uncommon; in either condition, the inflammatory character must be met by the application of cold lotions, or poultices, and other antiphlogistic measures.

Phagedænic ulceration comparatively seldom attacks chancre, and is connected with secondary symptoms of the most severe and intractable character; in the form of rupia, chronic periostitis and ostitis, sloughing ulceration of the throat and nose. Phagedænic chancroid is not infrequent. In either case, the ulceration may have the creeping and persistent form of *serpiginous* phagedæna, spreading to an unlimited extent. Treatment comprises free cauterization with strong nitric acid, or the actual cautery; opium, tonics, and a supporting diet; a temperate, quiet life, and fresh air. Ricord speaks highly of the potassio-tartrate of iron, and so also does Mr. Lee, both as a tonic and local application. A mixture of half an ounce of this salt to three ounces of water may be taken thrice daily, in doses of a tablespoonful, an hour after meals; and a solution applied to the ulcer as a dressing. The co-existence of phimosis, with sub-preputial ulceration, frequently occurs; and then the foreskin must be slit up, to reach the part affected.

Bubo.—(1.) *Indurated Bubo*, or a bullety, hard, and indolent swelling of one or more lymphatic glands, commonly in the groin, is generally the consequence of a previously indurated chancre, with accompanying systemic infection. No *preventive* treatment, therefore, can avail to avert the development of this kind of bubo, when, at least, the causative chancre has undergone induration. *Curative* measures relate to the treatment of constitutional syphilis, under the influence of which treatment the bubo may gradually subside and disappear by resolution; meanwhile occasioning little inconvenience. (2.) *Soft*, and *Suppurating Bubo* is usually the consequence of a similar kind of ulcer—chancroid; and both having simply a locally contagious nature, *this* causative bubo is amenable to treatment accordingly. *Prevention* may be accomplished by the early destruction, or abortive treatment, of the original chancroid, in the manner already explained. *Curative* indications comprise—the resolution of inflammation, if possible, in order to prevent suppuration; or in that event, the treatment of abscess, and of the resulting ulcer. Inflammation may be subdued by rest in the recumbent posture, cold lotions, local blood-letting, counter-irritation, or compression; aided by a somewhat

lowering general treatment, by saline purgatives and reduced diet. Leeches should not be applied except in this early stage; since any formation of matter near the surface might inoculate the bites, which would thus be converted into chancroids. Each bite had better be covered with collodion and a bit of adhesive plaster, as a protective from any adjoining source of contagion, if one such point happens to become a chancroid. Of counter-irritants; iodine paint may be used, or a strong solution of nitrate of silver, ℈iii. to ℥i. of water, with the addition of ♏xx. of strong nitric acid, as recommended by Sir H. Thompson; others prefer blistering, or even the actual cautery, as employed in French hospitals, by means of a pointed iron at a white heat, applied to numerous points over the bubo. Compression can be effected by a pad of compressed sponge and spica-bandage, afterwards moistened with warm water to cause the sponge to swell under the bandage. Ricord's pad for buboes offers another resource. But I have rarely found any repressive measure succeed among the large number of out-patients at the Royal Free Hospital. *Suppurating* bubo should speedily be advanced by poulticing, and opened without delay; before the formation of sinuses, which would undermine the thin, bluish integument, leaving it indisposed to cicatrize. The abscess is readily slit open with a curved, sharp-pointed bistoury or scalpel; observing to make a free incision, and in the vertical rather than in the horizontal direction, as the former cut allows a gaping outlet for the escape of matter when the thigh is raised. Any sinuses should then be followed up with a director, and laid open. If the glands at the bottom of the cavity appear isolated or pedunculated, they had better now be removed, instead of being extruded by a tedious ulceration. This may be done with the knife or scissors, or by touching the little mass freely with a stick of potass fusa. The latter is also preferred by some surgeons for opening the abscess, when it appears likely to become sloughy, as thus a cleaner and more thoroughly exposed cavity will be formed. Hæmorrhage is seldom much, and is easily arrested. The ulcer of the opened abscess always assumes a chancroidal character, and secretes virulent matter. A poultice is applied, or strips of wet lint, to the bottom of the cavity, and the sinuses; subsequently this dressing should be exchanged for the lotions applicable to chancroid, or in its varied conditions of inflammation or phagedæna. During the cicatrization of a healthy sore, this process of healing will often be promoted by the support of a compress and spica-bandage, and in all cases by keeping the patient at rest. No particular constitutional treatment is required, and mercury would certainly be prejudicial.

In the rare event of indurated bubo having suppurated, the local treatment is the same; but the constitutional influence of mercury or other general treatment may be employed with advantage.

Constitutional Syphilis.—Preventive treatment still claims our first consideration. After the development of chancre, and before constitutional syphilis is manifested by any secondary symptom, except, perhaps, induration of the chancre, there is yet an intervening period of blood-incubation—extending over about a month or six weeks, more or less, during which the development of constitutional syphilis may be intercepted. Otherwise, the blood will assuredly declare its noxious influence on nutrition, in due time; by some secondary disease of the

skin, by sore throat, iritis, and so forth. The impending evil is sure to supervene, in some form; the storm is sure to burst. There follows the *indurated* or infecting chancre, says Ricord—a blood diathesis pregnant with misfortunes and tempests. An infallible explosion of constitutional affections will ensue.

But if some such manifestations are inevitable, in the natural course of systemic infection, all experience concurs, I believe, in the possibility of averting them by medicinal intervention. By what particular preventive measures? Here opinions differ widely.

Mercury has long been, and is still generally, credited with the most potent prophylactic influence. The symptoms of its protective operation, constituting mercurialization, and the modes of administering mercury, will be noticed presently, in connection with the curative efficacy of this medicinal agent. It appears indisputable, that if mercury be not preventive of systemic infection, no other known medicinal agent possesses such influence in any perceptible degree. The chief difficulty attending investigations with reference to this question, is first to determine the natural course of local syphilis, in its *different* forms—whether or not systemic infection would assuredly supervene; and thus, with corresponding certainty, to estimate the positive and negative results of mercurialization, or of other supposed protective measures.

Remedial Treatment.—Mercury holds the first place, and *iodide of potassium* the second, in the present anti-syphilitic materia medica. It would be impossible and useless to enumerate all the various remedies for constitutional syphilis, which have been tried and failed, more or less entirely. Such are sarsaparilla, guaiacum, opium, conium, juniper, sassafras, dulcamara, etc.

Mercury seems to produce a systemic condition which is antagonistic to, and incompatible with, constitutional syphilis, in most of the forms of its manifestation. And, indeed, this positively remedial operation of mercury is rendered equivocal only by the fact that the natural tendency of syphilis to recovery requires further clinical observation.

The *symptoms* of the systemic influence of mercury, and of its sufficient operation remedially, are, a slight tenderness of the gums adjoining the teeth, with, perhaps, a slightly increased flow of saliva, fœtor of the breath, and a coppery taste in the mouth. But this degree of salivation must be maintained, until any secondary symptoms, whether as regards the skin, the throat, or the eyes, have entirely subsided; including also induration of the primary sore. Not until then can mercury be safely discontinued, with a view to the non-recurrence of secondary symptoms.

The *administration* of mercury is a matter of equal importance, and scarcely less so, the *kind* of mercurial preparations employed. It may be introduced into the system, through the gastro-intestinal mucous membrane, by pills or solution taken internally; or through the skin, by the rubbing in of ointment—inunction; or by exposure to vapour, known as fumigation, or the mercurial bath; or by inhalation. Sigmund advocates hypodermic injection.

Blue pill—pilula hydrargyri—from three to five grains, two or three times a day; or calomel, a grain or more, in the form of a pill, and taken as often; have long been favourite forms of administering mer-

cury. But these preparations are apt to produce irritation of the gastro-intestinal canal, and the liver, by their continued use—occasioning bilious diarrhœa and sickness, long before their beneficial operation on the system can take place. Their introduction is, in fact, thus intercepted, and the mercury is said to "run off by the bowels." A small proportion of opium—say, a quarter of a grain—combined with each pill, will tend to make the blue pill or calomel settle on the stomach. The *iodide* of mercury, combined with opium in the form of a pill, is the preparation which I have long been in the habit of prescribing. It is less irritating to the stomach, and equally remedial. The *liquor hydrargyri bichloridi*, in half-drachm doses, more or less, is a convenient form of administering mercury internally; but I use it rather to sustain the systemic influence of the iodide.

Mercurial *inunction* supplies a more sure method of affecting the system, without any collateral disturbance of the digestive organs. It consists in rubbing in a small quantity of some mercurial ointment on the inner or thin-skinned aspect of the thighs, every night. A drachm of the blue ointment, unguentum hydrargyri, may be thus continued nightly, until the gums are touched, and the secondary symptoms evidently subsiding. The ointment must be rubbed in until it disappears, and then the greasy surface should be left unwashed. This, however, is a laborious and dirty ordeal, an additional penalty for any one to pay besides having syphilis.

Mercurial *fumigation* may be preferable as a more cleanly and equally efficacious mode of introducing mercury through the skin. It consists in exposing the surface of the body, enveloped in a blanket up to the chin, to the fumes of some mercurial powder, which is heated until it rises in the form of vapour, and which can be advantageously associated with steam, as a vapour bath. For this purpose, an apparatus has been contrived by Messrs. Savigny. A more ready contrivance is a half brick, heated to a dull redness, on which the powder is placed, and set in a pan containing a little water. Calomel is the mercurial preparation generally employed; and fifteen or twenty grains, the quantity usually sufficient, will undergo volatilization, entirely, in fifteen or twenty minutes. The patient is then put to bed, so that the particles of calomel shall not be wiped off the surface of the body. This mode of introducing mercury is highly recommended by Mr. Lee, who observes that, in his experience, neither of the other modes removes the symptoms so readily as calomel fumigation; none is attended by so little mischief to the patient's constitution; and none is followed so seldom by a relapse. He extends it, as I have already mentioned, to the local treatment of primary sores; and by means of a tube and mouth-piece, the vapour of calomel can be conveyed to the throat, for the treatment of secondary syphilitic ulceration affecting that part.

Mercurial *inhalation* can be administered by a simple and efficient form of inhaler, which is easily constructed; a common earthen teapot, to the spout of which is attached a tube of vulcanized india-rubber, about a foot long, and provided with a bone mouth-piece, in shape like the amber of a meerschaum pipe. A scruple of calomel is placed in the teapot, and the little hole in the lid which allows the escape of steam is stopped with a peg of tightly rolled paper,—better than wood, which yields and loosens in driving it in. The pot thus equipped

is ready for use. Resting on an iron tripod stand, the bottom of the pot is exposed to the flame of a spirit-lamp, placed sufficiently near, so that the flame shall expand under the whole bottom. In two or three minutes, the calomel begins to pass into vapour, and, the lid having been raised for a moment to ascertain that fact, the patient is told to inspire through the mouth-piece, at the same moment closing his nostrils between his thumb and forefinger, and then to expire through the nostrils; and so on alternately, breathing in a naturally free and easy manner. After about ten or fifteen minutes, all the calomel will have been inhaled as vapour, save a small quantity which adheres as a thin, white film to the interior of the pot and tube.

In two cases wherein I have resorted to the inhalation of calomel-vapour for the treatment of secondary syphilis, with ulceration and sloughing of the throat—the teapot inhaler I improvised having been used—the following facts are worthy of notice for guidance in general.

(1.) In both cases, previous treatment by mercury, and iodide of potassium, administered by the mouth, had been tried, successively, and failed; and, in one case, it was impossible thus to continue the treatment, these medicinal agents being absolutely rejected by the stomach with nausea, and constantly recurring sickness.

(2.) The gradual process of inhalation,—ten or fifteen minutes, and the quantity used, twenty grains.

(3.) Explosive coughing after inhalation,—variable in period of sequence, in its degree, and duration, but subsiding spontaneously and permanently. This might be moderated by reducing the quantity of calomel to, say, half—ten grains, while the same beneficial influence might be gained by repeating the inhalation.

(4.) Slight salivation, in about forty-eight hours, and disappearance of the secondary symptoms; ulceration of the throat, especially.

(5.) Compared with mercurial inunction, and with the mercurial bath; the inhalation of calomel vapour is more speedy and effectual, in its systemic influence, than the one, and far more so than the other.

(6.) As to safety; in one of the two cases, the patient died, some days after inhalation, from bronchitis and pneumonia, but this patient had a very feeble venous circulation, and his constitution had been worn out by an Indian climate, and great intemperance, more than by constitutional syphilis. In the other case, the pulmonic effect of inhalation was inconsiderable, and the process was repeated on four different occasions, without any danger.

The *balance* of evidence, from these two cases, is, therefore, in favour of inhalation; and relatively also to mercurial inunction, and the mercurial bath.*

Excessive mercurialization produces symptoms which it may be convenient here to notice. They are; profuse salivation, swelling of the salivary glands, gums, tongue, and face, ulceration of the mucous membrane, loosening of the teeth, and even necrosis of the jaws. Diarrhœa, with bilious evacuations. Certain varieties of skin diseases, *e.g.*, mercurial eczema. Periostitis and ostitis, otherwise than connected with the mouth. Low fever with great prostration or mercurial erythism. Nervous affections—*e.g.*, neuralgic pains, partial paralysis, or mercurial tremor, sometimes complete paralysis and death; usually observed in those subject to the action of mercurial fumigation.

* Summary of a Paper read before the Harveian Society, London.

Iodide of potassium.—Not to be trusted for the prevention of constitutional syphilis, iodide of potassium ranks next to mercury as a curative agent; and especially in some forms of the disease, and in a certain constitutional condition, whether natural to the individual or morbid, where the action of mercury cannot be borne. It may be stated generally, that in the forms of skin eruption accompanied with plastic induration, in the earlier period of constitutional syphilis, and in young and vigorous subjects, mercury is most curative; whereas, in pustular eruptions, enlargement of the testicle, periostitis and ostitis, and any tertiary affections, in the later periods of syphilis, and in debilitated, cachectic subjects, iodide of potassium is the more remedial. But, perhaps, it may be added that its effects are less permanent than those of mercury, and thus the disease is liable to recur. Iodide of potassium is given in doses, usually from three to five grains, thrice daily, and combined with cinchona bark, cascarilla, or other vegetable tonic; this adjunct generally being requisite under the circumstances of suppuration or ulceration, wherein the iodide is prescribed. This medicinal agent was, I believe, originally brought into use for the treatment of constitutional syphilis, by Mr. Samuel Cooper, Mr. Morton, and other Surgeons at University College Hospital, about the time when I was a Student in that Institution; and it has since found much favour with the Profession. I have prescribed it with marked advantage in some thousands of cases, principally at the Royal Free Hospital.

Iodide of *mercury* has considerable repute with many continental surgeons; a grain being given in a pill three times a day, and gradually increased to three grains. Or, this combination may, probably, be effected in the system, by the concurrent administration of iodide of potassium or iodide of sodium, while mercury is introduced through the skin; thus obviating any irritation of the digestive organs which might be excited by giving the iodide of mercury itself.

Sarsaparilla has far less influence on constitutional syphilis than was formerly supposed, within my recollection. Its therapeutic value would seem to be restricted to the more asthenic or later secondary, and tertiary symptoms, and as occurring in debilitated subjects; the same circumstances which render iodide of potassium preferable to mercury. Or, again, mercury having produced a new series of symptoms simulating the syphilitic, sarsaparilla will then be remedial; or it may come into use at a subsequent period, to remove the *sequelæ* of a mercurial course. Sarsaparilla is thus, on the one hand, a substitute for iodide of potassium; or, on the other hand, an anti-mercurial. The decoction is the preparation usually employed, but it must be concentrated, and drank freely; in not less quantity than a wine-glassful three times a day. It may be advantageously combined with iodide of potassium; the two forming what has been indefinitely named an "alterative" mixture. Sarsaparilla has also a tonic influence, but less so than bark, and it is said to be diuretic and diaphoretic. This compound influence may give sarsaparilla an advantage over the more purely tonic operation of bark, when given in combination with iodide of potassium.

Guaiacum—another overrated medicine in relation to constitutional syphilis—is nevertheless, apparently, beneficial under similiar circumstances to those which render sarsaparilla—and iodide of potassium—

preferable to mercury; particularly in secondary affections of the periosteum or bone, and as occurring in cachectic subjects; or it may be useful in clearing off the effects of mercury. The stimulant and diaphoretic actions of guaiacum may, perhaps, explain its therapeutic influence in the course of secondary syphilis, and as an anti-mercurial.

It would be of little practical importance to enlarge this general view of the medicinal treatment pertaining to Syphilis. Excluding the many nostrums which, from time to time, have had a temporary remedial reputation; the details of the course of treatment, with reference to the various forms of skin eruption, and other secondary, and tertiary, syphilitic manifestations, can alone be taught at the bed-side, or learnt by experience.

The pathology and treatment of Syphilis are thus summed up by Mr. Lee:—

There are four varieties of local syphilis, resulting from the inoculation of the syphilitic virus, which are quite distinct, although they may occasionally succeed each other.

The *first* variety is accompanied by the adhesive inflammation, and produces a peculiar chronic enlargement of the inguinal glands, which does not involve the skin or the cellular membrane. This variety is followed by secondary symptoms, and requires, both in its primary and secondary forms, mercurial treatment.

The *second* is accompanied by suppurative inflammation. It does not affect the inguinal glands. It is not followed by constitutional diseases, and requires merely local treatment.

The *third* is accompanied by the ulcerative inflammation. It produces suppuration, generally of one inguinal gland only, which yields an inoculable secretion. It is not followed by constitutional syphilis, and may be treated by local means.

The *fourth* is accompanied by mortification. It does not affect the inguinal glands, is not followed by constitutional symptoms, and requires only local treatment.

Treatment of Congenital, Hereditary, or Infantile Syphilis.—The treatment of the congenital manifestations of Syphilis is advantageously considered in connection with that of the constitutional disease. And here also the surgeon should begin with the higher consideration of *preventing* the disease, before proceeding to the curative treatment of its manifestations in the infant after birth. It may be within the province and the power of the medical practitioner to thus preclude much domestic shame and misery, by timely counsel with regard to *marriage*, if he be consulted respecting such an important question. When may a syphilitic patient safely marry? Mr. H. Lee imposes only a fairly judicious restriction by allowing an interval of three years from the date of the primary stage of the disease, and that the patient shall have remained free of any syphilitic manifestation for the period of one year; but that even then the patient should be warned of the possibility of a relapse. When a syphilitic male patient is already married, but his wife is not pregnant, the husband should be candidly told of the risk of his transmitting the disease both to his wife and offspring; and he himself should be placed under specific treatment. When, unhappily, there is reason to believe, or suspect, that the woman is infected, *she*, also, should be treated accordingly, with

the view of preventing abortion, or the transmission of the disease to the *fœtus in utero.* Now this timely intervention can be accomplished only by a course of mercury. And it is better to administer mercury externally, by inunction, or by fumigation, rather than internally, by the mouth; for in the latter way, the treatment is apt to be defeated by the occurrence of diarrhœa, which might induce abortion. Miscarriage, perhaps on a second or third occasion, having been thus prevented, the fœtus is tolerated *in utero*, to perhaps the full period; and may then be born healthy, and continue free from syphilis. But in the event of there being congenital disease, namely at birth, or shortly afterwards, the same treatment should at once be resorted to, for its *curative* efficacy. The infant should be treated as a separate being, and protected also from the possibly contaminating influence of the mother, if she suckle her child—as morally she is bound to do, rather than that the unwarrantable risk should be incurred of infecting a healthy wet-nurse by the child. If the mother be weak, and thus physically unable to suckle, the infant should be weaned. Mercurial inunction may be conveniently applied to the child by Sir Benjamin Brodie's method; the mercurial ointment, made in the proportion of a drachm to an ounce of lard, is spread over a flannel roller, which is bound round the waist once a day. The child kicks about, and the cuticle being thin, the mercury is absorbed. It does not either gripe or purge, nor does it make the gums sore, but it cures the disease, and without fail. Very few children are said to recover, to whom mercury is given internally. But if this mode of administration be adopted, the hydrargyrum cum creta is perhaps the most efficient preparation, in congenital syphilis. At the same time, when the mother continues to suckle her child, she also should be kept under mercurial treatment, lest any further contamination be conveyed to the child, through the mother's milk. I do not know that such treatment of the mother has any indirect curative influence on the child, for its efficacy seems to be spent in the constitution of its first recipient, the mother. From careful analysis of the milk, in such cases, by MM. Lutz and Personne, it appears that not the slightest trace of mercury can be found in this, the source of the child's nourishment. Mercurial treatment must be continued until, and for some time after, all the symptoms of congenital syphilis have disappeared. Then iodide of potassium may be substituted, given in milk to the child; or, as this medicinal agent is probably eliminated in the mammary secretion, it may be administered through the mother. The weakly child should be weaned early, and reared artificially with more nourishing food; cow's milk, and perhaps veal or chicken broth.

The local treatment of the syphilitic eruptions, cracks and fissures, comprises the application of slightly stimulating ointments and lotions; with scrupulous cleanliness, by sponging the fundament more especially, and the use of clean linen.

Syphilization yet remains to be noticed. It is said to be the *curative* treatment of constitutional syphilis by repeated inoculation with the syphilitic virus, and for the *prevention* of its recurrence. Syphilization is also practised for the cure of primary ulcers, under the influence of which it is said they soon lose their hardness and begin to cicatrize. Buboes are thus affected beneficially. Vegetations remain uninfluenced.

This method of treatment, originated by M. Auzias-Turenne, about 1845, and adopted by M. Sperino, is specially advocated by Professor Böeck, of Christiania, with reference to constitutional syphilis; and, in 1865, he visited this country to inculcate his views by practical illustration in the Lock Hospital. The matter from a primary syphilitic ulcer, hard or soft, the former being preferable, or that from the artificial sore of a patient undergoing syphilization, is inoculated or introduced, in the same way as vaccine matter. To prevent large ulcers and cicatrices, the inoculations are commenced on the side of the trunk. Three inoculations are made on each side. After three days, pustules will have formed, and from these, other inoculations are then made. This is repeated every third day, the matter being always taken from the last pustules, until no further effect can be produced with this matter. Fresh matter is now introduced, from another patient; pustules ensue as from the matter first used, but the pustules and ulcers resulting from this second matter are not nearly so large as those originally produced. A third matter elicits pustules and ulcers yet smaller and fewer in number; until, ultimately, no matter applied to the sides will produce any specific effect. But the arms and thighs are still susceptible to inoculation, either from fresh matter or from matter of the last pustule. The process is therefore now repeated on these parts in succession, until there also an immunity is obtained. Ordinarily, this occurs in from three to four months.

The conclusions arrived at by Professor Böeck are:—

(1.) That artificial chancres on the sides and on the arms are always smaller than those on the thighs, and the series of inoculations shorter.

(2.) By continued inoculation the ulcers always become less and less, until at last inoculation gives a perfectly negative result.

(3.) The inoculated individual grows insensible to one matter, but is still susceptible to another, yet in a lower degree; and again to a third matter, but in still lower degree; and so on until no further effect is produced by any matter.

(4.) Immunity having been obtained on the sides and on the arms, it will still be possible to have rather a long series of inoculations on the thighs.

All these phenomena are said to be constant; they do not occur in one individual and not in another; they will always be presented. "We have here an invariable law of nature."

A *saturation* of the system with syphilis—according to MM. Auzias-Turenne and Sperino—is thus established; a syphilitic *diathesis* —according to Dr. Böeck—which, when once established, cannot be increased or intensified by the further inoculation of virulent matter. But the continued insertion of this matter stimulates the disease, and enables it to pass through its regular course; thus completing the series of phenomena which follow systemic syphilitic infection, in a *far shorter period* than if left to itself, or subjected to any other method of treatment. Relapses, and the supervention of the so-called tertiary disease, are therefore rarely found after this curative treatment; whilst the continued introduction of syphilitic matter into the system destroys, in a varying period of time, the susceptibility of the individual; ultimately producing a local as well as a general immunity to the disease, which constitutes its preventive treatment.

Patients of all ages, even very young infants who are the subjects of *hereditary* disease, have undergone this course of treatment. In the latter, however, inoculations will frequently not take effect; nor in persons with acquired constitutional syphilis, who, at the same time, are suffering from some acute or debilitating disease. But the latter adverse conditions are temporary, and immunity is generally obtained. Its duration in regard to the local action of the virus is limited, freedom from susceptibility to the production of chancre being gradually lost after the inoculations have been discontinued; but the systemic immunity continues, and frequently throughout the life of the patient.

These results have been attested, it is said, by some hundred of cases. It is admitted, however, that the success of syphilization is very much modified by the fact of whether, or not, the patient had previously undergone mercurial treatment. Dr. Böeck alleges that mercury interrupts and retards the natural course of syphilis, and that, in like manner, it interferes with the treatment by continued inoculation,—thus diminishing the curative efficacy of syphilization.

It was at this stage of the inquiry, more particularly, that syphilization was tested at the Lock Hospital, in twenty-seven cases, under Dr. Böeck's immediate supervision. Mr. James R. Lane and Mr. Gascoyen —the surgeons to that Institution—have supplied an elaborate report of these cases; which, while it contributed interesting particulars on points connected with the clinical history of syphilization, and indirectly with the pathology of Syphilis, condemns it as a method of treatment. On this aspect of the question, the report concludes:— "We are entirely in accord as to the practical bearings of Syphilization, and we are decidedly of opinion that it is not a treatment which can be recommended for adoption. We consider that, even if it could be admitted to possess all the advantages claimed for it by its advocates, its superiority over other modes of treatment, or in many instances over no treatment at all, would not sufficiently compensate for its tediousness, its painfulness, and the life-long marking which it entails upon the patient.

"If Syphilization could be relied upon, after other treatment had failed, to control the severer forms of the disease, especially in its tertiary stage, or to prevent its hereditary transmission, the benefit derived would, without doubt, more than counterbalance these disadvantages; but unfortunately these are precisely the cases in which it has admittedly the least influence." ("Med.-Chir. Trans.," 1867.)

CHAPTER VIII.

ERYSIPELAS.

Erysipelas is a blood-disease, manifested by a diffuse and spreading or serous inflammation of the skin and subcellular texture, possibly also of the mucous membranes; and of an infectious character. The latter element of this definition is disputed, and indeed open to doubt.

Any such doubt, and disputation, seem to have arisen from one oversight—that of associating erysipelas, as a diffuse inflammation of the skin and subcellular texture of the *head* and *face only*, with *erysipelatous inflammation* of the skin and subcellular texture of any other part of the body. The former is decidedly infectious; the latter, apart from co-operating causes, *less* decidedly so.

According to some authors, the pathology of erysipelas is enlarged so as to include almost any diffuse and spreading inflammation; as when arising from the contagion or local introduction of decomposing animal or *septic* matter; *e.g.*, the cellulitis proceeding from a poisoned wound; with which may be associated diffuse phlebitis and diffuse lymphatitis. But thus would be placed in the same class, diseases which, having the resemblance of appearance, as inflammation, yet differ in their pathology, especially with regard to their infectious or non-infectious nature.

Simple or *Cutaneous Erysipelas.*—The inflammation is located principally in the papillary layer and rete malpighii of the skin. (Billroth.) Commencing in the integument of the head or face, simple erysipelas exhibits the following characteristic appearances:—On the nose, either cheek, the margin of either ear, or sometimes on one of the temples, a slight blush of redness becomes visible, accompanied with stiffness rather than swelling of the *skin*; which has lost only its wonted suppleness, and acquired a shiny roseate hue. A tingling, burning sensation also, rather than pain, is experienced, and hence the popular name of this inflammation—St. Anthony's Fire. The redness of erysipelas assumes different tints; usually being more scarlet, rather than purple; but of whatever tint it may be, it disappears entirely on pressure, and returns immediately the finger is withdrawn—so free and persistent is the determination of blood. The tension also of the skin is readily perceived on passing the finger from the sound to the inflamed part. An abrupt margin defines this redness and this stiffness; both are circumscribed by an irregular line.

The inflammation, thus mapped out, spreads continuously: erysipelas is, *par excellence*, a creeping skin affection; and while it diverges, creeping like water spilt on an impervious surface, the skin becomes swollen, some serum is effused into the subcellular texture also, and *this* swelling is soft and diffused. Nature makes no adequate reparative effort to limit and circumscribe the serum with lymph. Serous effusion, therefore, proceeds, and the swelling increases—so much so as to close the eyelids, distend the cheeks, disfigure the features, and, at length, obliterate all traces of personal identification. "What great events from little causes spring:" that trifling red nose, and now this defaced visage!

Terminations.—At this stage of the inflammation its course is sometimes arrested, the redness fades, the swelling subsides; and this termination by *resolution* occurs with, or without, shedding of the cuticle, in silky scales, or a branny powder, at the end of three or four days. In many instances, however, the issue is less speedy. Serous effusion, having continued for a period varying from twelve to thirty-six hours, elevates the cuticle into vesicles, or larger blebs, exactly like those which follow a burn or scald. These semi-transparent and yellowish, or sometimes livid blisters, soon burst, and

discharging their contents—serum, pure or bloody—subside into thin incrustations. When, in the course of a week or ten days, these peel off, they disclose the subjacent skin either in a sound state or beset with superficial ulcerations. Suppuration, in the form of small subcutaneous abscesses, sometimes occurs. In some instances the true skin is less spared. It has a reddish-brown or livid hue, and even *gangrene* of the *skin* succeeds; announced by great tension, heat, and acute pain. But this issue of erysipelas is rare, and generally fatal.

Such are the origin, course, and terminations of *simple* erysipelas—an inflammation akin to erythema, and contrasting with the *phlegmonous* variety, in which the *skin* and *subcellular* texture are both the seat of inflammation—the latter tissue being more especially, but secondarily, engaged.

Diagnosis.—It is highly important to distinguish *simple* erysipelas from certain other diseases, which bear more or less resemblance to this cutaneous inflammation. *Erythema* is an inflammatory affection of the skin, which presents a pale rose colour, with slight tension of the skin, and is attended with a tingling or painful sensation; but this inflammation appears in the form of irregularly circumscribed patches, of variable extent and number, and which have not the spreading character of erysipelas. Any part of the body is liable to be attacked with such patches, but the trunk or limbs are more commonly affected; rarely the head. The accompanying febrile symptoms are slight. Erythematous inflammation is transient, subsiding with efflorescence, in a week or two; or it may assume a chronic character. The varieties of erythema are distinguished principally by the shape, size, and colour of the flattened patches; in one variety, however, *E. nodosum*, the patches are elevated, and somewhat indurated, in the form of oval and more or less firm swellings, to the extent of two or three inches long, and which have a red or purple hue. They are commonly seated on the shin; and so far might be mistaken for syphilitic nodes. Certain *diffuse* inflammations of the subcutaneous cellular texture more nearly resemble simple erysipelas in appearance. *Capillary lymphatitis* is one such inflammatory affection of the smallest lymphatic vessels beneath the skin, to which I would especially direct attention, with regard to diagnosis. This inflammation appears in the form of a *uniform* blush of redness, unlike the ramified streaks presented by the larger lymphatics when inflamed; the redness is of a pale rose tint, and is accompanied with little or no cutaneous tension to the touch of the finger,—these two characters differing so far from those of simple erysipelas, to which perhaps may be added the less-marked boundary of capillary lymphatitis; yet in both diseases the inflammation has the same continuously spreading character. But in respect to their causative origin, the distinction is most manifest; erysipelas generally being communicated by infection; whereas capillary lymphatitis is always of traumatic nature,—as a diffuse subcutaneous inflammation of the smallest lymphatics, proceeding from an open wound, or even a subcutaneous lesion, perhaps only friction of the skin. Traumatic erysipelatous inflammation arises only in connection with a wound; and, indeed, it may be doubted whether, usually, the traumatic erysipelas, so called, is not essentially capillary lymphatitis. From erythematous inflammation of the skin, this inflammatory affection of the subcu-

taneous lymphatics may be distinguished by its not appearing as numerous patches, in different parts of the body, but only in connection with the local lesion, from whence it arises; and by the spreading character of the inflammation.

Phlegmonous, or Cellulo-Cutaneous Erysipelas—and its Diagnostic characters.—Another form of the inflammation—*phlegmonous* erysipelas —presents different characters from those of simple erysipelas. The roseate hue, if it should appear in the first instance, is soon exchanged for a brownish or livid tint which mottles the skin. The subcellular texture is gorged with serum, and exhibits a considerable swelling, which, however, readily pits on pressure with the finger. This *œdematous* swelling, of considerable size, and this *purple* shade of colour exhibited by the skin, contrast with the characters of simple erysipelas as it first appears. The burning pain also is more severe, and perhaps accompanied with throbbing. Otherwise, the simple and phlegmonous varieties have points of resemblance. In both, the redness presents a defined margin; in both, the inflammation extends itself continuously by creeping over the surface. But then again, in phlegmonous erysipelas, serous infiltration of the subcellular texture advances and deepens with alarming rapidity; and although itself diffused, the stuffed cushion of cellular tissue soon feels *brawny*. A few small vesicles only represent the overflow of serum under the cuticle; they do not reveal the perilous state of affairs beneath the skin.

Terminations.—Burrowing *suppuration* and rapid *sloughing* threaten; these dangers *not* being attended with increased tension, swelling, and pointing, as in phlegmonous inflammation; on the contrary, rather with diminished tension, subsidence, and flaccidity. At that period, observes Dupuytren,* when phlyctenæ have formed, and the cellular texture becomes thickened and indurated, the symptoms appear for two, three, or four days to be stationary; and an inexperienced surgeon is even led to hope for the resolution of the inflammation, while the danger is really urgent, and suppuration already exists. This, then, is the critical period of phlegmonous erysipelas. If unchecked, the conclusion of its career may be told in a few words. Very soon after this period of deceitful calm comes an outburst. A more livid hue overshadows the integuments; the skin melts away in patches, accompanied with a discharge of bloody sanious fluid, and the exposure of white sloughs of cellular tissue, portions of which bulge here and there through apertures in the integument. Sometimes this texture perishes extensively, but if partially spared, large sloughs of cellular tissue, resembling masses of soddened tow, are eventually detached; while the adjoining cellular texture is drilled with small abscesses, or a profuse suppuration burrows wherever fluid can find its way—between muscles, and possibly into a neighbouring joint. Thus all parts around become involved in the ravages of phlegmonous erysipelas. In one fatal case, under Dupuytren's observation, the whole leg was laid bare of skin and cellular tissue, exposing the tibia and patella. After prolonged suppuration and sloughing, those textures which do escape—the muscles, fasciæ, tendons, and bones—are so agglutinated together as to seriously and permanently impair their uses in the animal economy.

* "Clin. Chir." t. ii. p. 311.

Diagnosis.—Two forms of inflammation affecting the subcutaneous cellular texture—the one diffuse, the other circumscribed—must be distinguished from phlegmonous erysipelas. *Cellulitis* sometimes occurs in the form of a subcutaneous and diffuse inflammation, which so far resembling phlegmonous erysipelas, these two diseases are associated, according to the pathology of some authors. But, as in the diagnosis of other diseases, no constant differences of character can possibly be referable to diseases of essentially the same nature. Thus, cellulitis may be recognized by a diffuse, œdematous, and spreading swelling, with the *absence* of cutaneous inflammation; there being perhaps scarcely the slightest blush of redness in the skin, although the pain is severe. The skin may become secondarily involved, by advance of the cellular inflammation from beneath upwards; but the subcutaneous cellular tissue is primarily and essentially the seat of the inflammation. Cellulitis arises from *various* blood-poisons; which may be introduced, either through a poisoned wound, or by atmospheric influence affecting any wound, or gain access to the circulation through inhalation. Thus, the etiology of diffuse cellular inflammation' comprises the blood-poisoning from a snake-bite or a dissection wound; and in the idiopathic form of the disease, as unconnected with any wound or surgical operation. But the disease does not appear to be the offspring of infection, or to have an infectious character. The febrile disturbance in cellulitis is more profoundly of the typhoid type, than in phlegmonous erysipelas; it runs its course more rapidly, and the exhaustion is more overwhelming, and generally fatal. The etiology and constitutional symptoms may, therefore, be taken in conjunction with the characters of the cellular inflammation, as a wider ground of diagnosis between these diseases.

Phlegmonous inflammation contrasts with phlegmonous erysipelas in certain particulars, and which determine their diagnosis—a question of much importance. Circumscribed and limited infiltration of the subcutaneous cellular tissue with coagulating lymph is the essential pathological condition peculiar to phlegmon. It is an inflammation of the *cellular texture primarily*, the skin being only secondarily involved; whereas phlegmonous erysipelas selects, first, the skin, and then involves the subcellular tissue. *Coagulating lymph*, rather than serum, is effused in phlegmon; the consequent swelling is therefore *circumscribed* and *limited*, instead of being diffused and wide-spreading; it is also *brawny in the first instance*, that of phlegmonous erysipelas becomes so gradually; lastly, respecting the issue of these two species of inflammation, that of erysipelas is *prone* to slough, while that of phlegmon is liable only to this termination.

It seems unnecessary to add a third *form* of Erysipelas—the "œdematous" of some pathologists, for the phlegmonous form is itself œdematous in one stage of its career. In both, a diffused infiltration of the subcutaneous cellular texture with serum is conspicuous, and the pitting of this œdema on pressure with the finger is its most distinctive character.

Erysipelas may spread from the scalp and face to the neck, thence to the thorax, and occasionally extend as far as the extremities; or it may begin in some other part than the head and face—such as the leg, sometimes the trunk. In whatever part of the body Erysipelas first shows itself, its characters and course are similar; but while

fading in that portion of the skin where it first appeared, it travels to the neighbouring skin. The various stages of this inflammation, therefore, usually co-exist in different parts of the skin; the portion last affected being red and swollen, another part vesicated, while others are undergoing desquamation. So marked sometimes is the spreading or progressive character of the inflammation, as to have received the name of *E. ambulans.* Or, if not spreading continuously, but subsiding and migrating from part to part, this variety has been named *E. erraticum*, or *metastatic*, when migrating possibly to some internal mucous membrane, or serous cavity. Thence, *complications* are occasionally met with, as in other eruptive fevers. For example, meningitis may occur in connection with erysipelas of the face; pleurisy, when the trunk or other parts are affected.

Fever.—Erysipelas is preceded by, and attended with, a fever of the typhoid type; but which is generally characterized by a marked derangement of the digestive system, especially of the liver, so that the patient may become more or less jaundiced. Commencing, usually, with smart rigors, and a hot, dry skin, followed by perspiration, perhaps profuse; then the erysipelatous inflammation makes its appearance. Sometimes, however, the premonitory symptoms are simply a sense of weariness with a chilly feeling, ere the cutaneous or cellulo-cutaneous inflammation is declared. But in either case, the gastric and hepatic derangements are denoted by a yellow, flabby, steaming tongue, which soon assumes a dry, brown, and corrugated aspect, with bitter, hickuppy eructations, nausea, and epigastric oppression; the bowels are constipated, or pass only lumpy, dark-coloured, and offensive motions, issuing in diarrhœa; while a yellow tinge overspreads the skin and conjunctivæ. This retention of bile in the blood is shown also by the state of the urine, which has an orange-red colour; the secretion is scanty, turbid with lithates, and loaded with urea; sometimes a varying proportion of albumen is found on examining the urine with the usual tests of heat and nitric acid. The circulation labours under the influence of the blood-poison. On the accession of the fever, the pulse increases in frequency, and the temperature rises from 98° to 100° or 102°, during the apparent coldness of the rigor-stage; but soon the supervention of exhaustion is manifested by the feeble, irregular, and liquid or thready character of the pulse, which often, however, retains its rapidity. The temperature gradually declines as the inflammation subsides; or rises daily, morning and evening, especially as the inflammation continues to spread, or returns in an erratic form. In unison with the circulation, symptoms of nervous depression are evinced by the clasping headache and drowsy sleeplessness, which may be noticed in erysipelas of the head and face, more especially; and sometimes, maniacal excitement having prevailed for a time, the low muttering and wandering delirium of typhoidal fever overwhelms the patient, as he sinks into the arms of death. On the other hand, there can be no more favourable omens than a subsidence of the pulse and temperature; both gradually returning to the normal standard, as the blood-poison seems to have spent itself in the inflammation, and the red or purple hue of the skin fades away, not prematurely, but in the natural termination of the attack.

In the course of erysipelatous fever, the premonitory symptoms of rigor or chilliness may not be followed by the outbreak of cutaneous

inflammation until after a period of from twenty-four hours to two or three days; during which interval, however, other symptoms announce the approaching attack. Thus, pending erysipelas of the head and face, a diffuse inflammation of the fauces, or "sore throat," generally precedes, and accompanies, the cutaneous inflammation; and, indeed, this affection of the mucous membrane is, according to some observers, an invariable accompaniment of the initiatory fever of idiopathic erysipelas. Swelling and tenderness of the lymphatic glands may be the forerunner of an erysipelatous outburst in an adjoining part; as of the cervical glands with relation to erysipelas of the head and face. A wound or ulcer assumes an unhealthy character; the granulations losing their florid hue, and the purulent secretion becoming thin and sanious. It may be here noticed, that when erysipelatous inflammation sweeps over a cicatrix, the new tissue often begins to ooze, and threatens to reopen; as I have seen after excision of the hip-joint. But in a case of knee-joint excision, I have known a most violent attack of erysipelas pass over the seat of recent union without loosening the recent anchylosis.

Blood-pathology.—Erysipelas has been thus examined, yet with little result. The blood is rich in fibrin, and poor in globules; but these alterations, together with others that occur, are common to all the phlegmasiæ. They are not peculiar to erysipelas, and therefore not characteristic. *Post-mortem* examination, in the uncomplicated disease, reveals no apparent cause of death; no organic changes, except a tendency to disintegration, softening, and blood-staining, common to all blood-diseases.

CAUSES.—*Infection.*—Erysipelas may be caused by infection—*i.e.*, it may be produced by inhalation from a person having the disease. But this mode of production is observed only in some cases. Certain cases reported by Dr. Wells * are much to the point. An elderly man was attacked with erysipelas of the face, and died in about a week from the time when Dr. Wells first saw him, viz., on the 8th of August. On the 18th of the following month an elderly woman, landlady of the house in which the old man had been a lodger, came under the care of Dr. Wells, also with erysipelas of the face. On inquiry it was found that the old man's wife had been seized with erysipelas a few days after his decease, and had died in about a week. Another old woman, who had nursed the landlady, was also attacked with this disease and died. Lastly, a young man, nephew of the old man, was seized, shortly after visiting his uncle, and died in a few days. In this last case the probability of infection having been the cause of erysipelas is obvious, and with some probability the same mode of propagation may be inferred respecting the whole series of cases. For the report further states, that the landlady had been several times with the old man and his wife during their sickness, and that after their death she had removed some furniture from the room they had occupied to her own apartment. Cases of like import occurred in the practice of Dr. Wells's contemporaries—Mr. Whitfield, apothecary for very many years to St. Thomas's Hospital, Pitcairn, and Baillie, who made similar observations in St. George's Hospital during the years 1795–96. Many years afterwards, to show the growing impression in favour of this doctrine, I might

* "Trans. of a Society for the Improvement of Med. and Chir. Knowledge," 1800, vol. ii. p. 214.

refer to cases of infectious erysipelas, recorded severally by Dickson,* Blackett,† and Stevenson.‡ Then Mr. Arnott § took up the inquiry. He collected what had been done by others, and added the results of his own observations. "In one family, the mother was first affected with inflammation of the pharynx, terminating in mortification. On her death the husband was attacked with inflammation of the throat and erysipelas of the face. As he recovered, the daughter was similarly seized with inflammation of the pharynx and severe erysipelas." Five years prior to this paper, although published subsequently, a series of observations yet more convincing, if possible, were made by Dr. Gibson.‖ For example, the infant son of a gentleman was seized with erysipelas on one foot. Afterwards, the mother became affected with erysipelas of the face and scalp. Then the nurse, who suckled the child, was attacked with symptoms of pneumonia. She was removed to her father's house, four miles off. He, who some days before her arrival had received a wound of the scalp, was now seized with erysipelas of the face and scalp, and died. Soon afterwards, a sister, living in the same cottage, had fever with sore throat, from which she slowly recovered. Two children, in the same house, were cut off with what appeared to be croup.

Taking a fair estimate of all these cases, it will be obvious that those are most decisive where the persons who became affected resided at some distance from the house in which erysipelas first manifested itself. Persons living together might possibly be subject to some endemic source of disease, as bad drainage, or insufficient ventilation.

But if the fact of persons acquiring erysipelas, after associating with those who have this disease, is in favour of its propagation by infection; so also, when the source of contamination is removed, the disease should cease to spread. Of this the following is an illustration:—The wards of the Dublin Fever and Dysentery Hospital were large and extremely well ventilated. "On paying my daily visit," writes Dr. Brereton,¶ "I observed one of the patients, who had been admitted with fever some days previously, to be formidably attacked with erysipelas. On the following day I found the patient in the next bed seized with it. On the third day, two patients in the adjoining beds were similarly attacked. I then," continues Dr. Brereton, "became seriously of opinion that the disease was contagious, but resolved not to have those already affected removed until I had tried the result of another day. On the following morning, I found three more in like manner labouring under the disease; and what made it more remarkable, they were all similarly attacked in the head and face. I had them immediately put into another ward, where there were no patients; they all recovered, and no more erysipelas afterwards appeared." In this series seven patients were attacked successively, but here the supposed cause being removed, its effect ceased.

Respecting, then, the propagation of erysipelas by infection, we have the *double* test of causation fulfilled; the presence of erysipelas is

* "Med.-Chir. Jour.," April, 1819, p. 615.
† "Med. and Physical Jour.," April, 1826.
‡ "Edin. Med.-Chir. Trans.," vol. ii., 1826.
§ "London Med. and Physical Jour.," 1827, vol. vlii.
‖ "Edin. Med.-Chir. Trans.," vol. iii., 1829.
¶ "Dub. Jour. of Medical Science," vol. vi. p. 176.

at once followed by this disease in persons associating therewith, and, being withdrawn, the disease at once ceases to multiply.

It has been affirmed by some men of observation that this law holds good *only* of erysipelas affecting the face and scalp. Arnott and Watson are of this opinion; but, restricting, as they do, their definition of this disease to its manifestation on the head and face, the law of infectious propagation becomes absolute. Other authorities, however—and the majority—who do not take this localized view of erysipelas, are inclined to acknowledge its propagation by infection. I can throw into the scale my testimony as to the infectious character of facial erysipelas, and probably of every *idiopathic* manifestation of the disease on any part of the body.

Are *fomites* capable of transmitting this disease? Yes, certainly. Among the earlier writers, Wells observed that a certain patient caught erysipelas in consequence of being laid in the unchanged bed of one who died of it. In one of my cases of knee-joint excision, two months after the operation, when the union was fairly firm and the wound had entirely closed, the patient, a female, aged fifty-three, caught erysipelas from having been transferred to a bed where the mattress had been accidentally stuffed with some flock previously used in the bed of an erysipelas case. The attack, thus communicated, was so severe—the inflammation extending up the limb to the loins and lower part of the abdomen—that she nearly lost her life. But the wards of an hospital may themselves become contaminated, and communicate the disease on a larger scale. By Gibson's report, already quoted, we learn that a woman, with erysipelas of the hand, having been admitted into the Montrose Infirmary, and the patients in either adjoining bed having become affected, the whole ward was then cleared out, cleansed, whitewashed, and fumigated. "Yet when they were again placed in that ward the disease reappeared," and it became necessary to remove all the patients from this little infirmary, and to take every precaution ere the infection was eradicated. The contaminating power of fomites, in the shape of furniture, floors, etc., is evinced by the fact that dry-scrubbing instead of washing the floors of an hospital, or the decks of a ship, is the surest safegnard against this source of infection. Bnt fomites of all kinds retain most tenaciously the poison of erysipelas; and, indeed, Gregory is of opinion that this poison is banished with more difficulty than other known miasm.

The *period of latency* or *incubation*—varying in each kind of infectious disease—in erysipelas, extends from two to fourteen days; and when developed, the *infecting area* is twenty to thirty feet.

External causes.—Erysipelas acknowledges, apparently, a *traumatic origin*, in some instances. Hence all kinds of wounds, injnries, surgical operations, and irritants, such as blisters, canstics, etc.—are accredited causes of this species of inflammation. Besides mechanical and chemical irritants, heat and cold may be accorded their share of importance.

The situations or parts of the body more commonly affected with tranmatic erysipelas, may be arranged, according to Billroth's experience, in the following order of frequency: the lower limbs, then the face, upper extremities, breast and back, head, neck, and abdomen, this scale corresponding to the proportionate frequency of injuries in the different parts. Sometimes, erysipelas appears and proceeds as

an *epidemic;* the disease seeming to be the offspring of some unknown atmospheric influence. Or again, it may have an *endemic* atmospheric origin; the disease arising from the overcrowding of patients in the ward of an hospital, deficient ventilation, or defective drainage. In like manner, the *uncleanly dressing* of wounds is an accredited source of erysipelas, and of its propagation.

Predisposing causes.—Any external cause may be reinforced, at least, by conditions within the body; resulting mostly from previous habits of *intemperance*, previous hardships, or both, perhaps also from mental depression—circumstances which have depraved the blood and enfeebled its circulation. But the disease is also most prevalent in spring and autumn, or at least when hot and cold wet weather alternate; and if period of the year has some predisposing influence, so also has the period of life, they being most liable who are *old* in years, or old for their years.

Apart from predisposing causes, erysipelas, probably, would not arise; with their concurrence the scratch of a pin only may be apparently the traumatic origin of this disease. Yet even in such cases its infectious character becomes developed. In one instance, noticed by Lawrence, erysipelas of the head and face, consequent on the insertion of a seton in the neck, was the only presumptive cause of this affection in two other persons. Travers, indeed, goes so far as to affirm that he has repeatedly seen the "idiopathic" arising from the "traumatic," or this from the former, and either from its own source.

Lastly, the possibility of erysipelas arising *spontaneously*—that is to say, in an individual without any assignable external cause, and therefore without infection—is, I think, indisputable.

The *recurrence* of this disease in the same individual is possible. I can speak from my own personal experience, having had it *four* times severely, in my head and face, when from nine to thirteen years of age. I was then a pupil at the King's College School, and although many years have elapsed, I well remember the flaming pain, and that my face was like a distended bladder. I just mention these particulars to verify so early a reminiscence in evidence of an important fact, that susceptibility to *true* erysipelas—*i.e.*, affecting the head and face—is not exhausted by one attack. Unlike most eruptive fevers, the blood does not lose its capability of undergoing this infection, again and again.

Prognosis.—The constitutional conditions which rank as predisposing causes of erysipelas, mainly suggest the prognosis of this disease. In persons of intemperate habits, and who are the subjects of degeneration of the kidneys, with albuminuria, or of the liver with a tendency to jaundice, erysipelas is generally fatal. In the aged, or persons of prematurely old and broken constitution, the prognosis is unfavourable. These adverse conditions owe their significance to the retention of excrementitious matters in the blood, or blood-poisoning, coupled with an enfeebled circulation. But the form of erysipelas, the part affected, the extent of the inflammation and the destruction of texture, the co-existence of other diseases as complications, or of various injuries when the erysipelas is of traumatic origin, have each their special share of importance in determining the issue. Thus, simple cutaneous erysipelas is less perilous than the phlegmonous or cellulo-cutaneous form of the disease; but, as affecting the head espe-

cially, or the trunk, the danger is greater than when either limb is the seat of the inflammation; although the destructive character of phlegmonous erysipelas, in the course of suppuration and sloughing, may prove fatal by exhaustion.

Treatment.—*Preventive* measures must have reference to the causes of this disease. Its propagation by infection suggests the prompt isolation of any person having erysipelas—as the source of infection, free ventilation of the apartment, and the separate use of any bedding or other infected article, which might act as a *fomes* in carrying the disease to other patients. Dry-scrubbing instead of washing the floor of the bedroom or ward, has already been alluded to as a safe-guard; evaporation favouring, apparently, the dissemination of the infected atmosphere. Cleanliness with regard to the dressings used for other patients, and on the part of the nurses, is an obvious injunction. With all these precautions, a nurse or the practitioner himself may yet be the medium of communicating the disease. Disinfectants, such as chlorine vapour, or chlorinated solutions, permanganate of potash, and carbolic acid lotions, have more or less influence in purifying a contaminated atmosphere, or in guarding the wounds of patients who may be exposed to its operation.

These preventive measures are less urgent with reference to erysipelas of traumatic origin.

Predisposing causes, pertaining as they mostly do to the previous health of the individual, scarcely admit of prevention. They suggest, however, the greater protection of persons thus liable to infection. Such are persons whose blood has been depraved, and circulation enfeebled, by previous habits of intemperance, and by the wear and tear of a laborious, anxious life. Albuminuria is peculiarly inviting to erysipelas. Diabetic patients also are said to be liable.

Remedial treatment—so-called—is a misnomer; for, like all infectious diseases, erysipelas runs a certain natural course, and the only power of art is to avert any unfavourable tendency. It is probable that a blood-poison is undergoing elimination from the system, through the great secreting surfaces—the skin, thus inducing the inflammation, and the mucous membranes. Consequently, the bowels having been evacuated by a mercurial and rhubarb or colocynth pill; a saline aperient, diuretic and diaphoretic mixture, may then be given with advantage for some days. Thus, the sulphate of magnesia, with nitrate of potash and small doses of tartarized antimony, seem to promote elimination. The acetate or carbonate of ammonia, in camphor mixture, will be more specially diaphoretic. Bicarbonate of potash, in large doses, say half a drachm, has sometimes appeared to me to fulfil a special purpose, that of neutralizing the blood-poison, whatever it be. Erysipelas is, I think, thus allied to rheumatism or rheumatic gout, to erythema and urticaria; in all of which diseases potash has some peculiar remedial influence. And in harmony with their therapeutic affinity, I have observed clinically, that the same individuals are not unfrequently subject to each of these diseases. A dusky yellow hue of the skin, and slight yellowness of the conjunctiva, with perhaps nausea and oppression of the stomach, are often present in erysipelas. This condition, verging on jaundice, is best overcome by the repeated administration of calomel or blue pill, to restore the secretion of bile. A blister over the region of the liver is also, I

believe, recommended by Mr. Syme. These measures are apparently more efficacious than the ipecacuanha emetic usually ordered to empty the *stomach*.

The saline plan of treatment will, generally, prove sufficiently depletory—as well as excretory—without having recourse to blood-letting, to however small an amount. Debility, and the increasingly typhoid character of the fever, from the commencement of the disease, soon indicate the necessity for the substitution of a stimulant and tonic treatment. Carbonate of ammonia, in five or ten grain doses, with disulphate of quina, in similar or even larger doses, may be given every four hours. Tincture of the sesquichloride of iron, from ten to twenty minims every two hours, is highly extolled by Dr. Balfour, as a certain and unfailing remedy, whether the erysipelas be infantile or adult, idiopathic or traumatic.

The *diet* must correspond to this medicinal treatment. Wine should be given, tolerably freely, in all cases, and even from the very beginning. Brandy and egg beat up together, form a convenient and agreeable mixture, at once stimulating and nourishing. Beef-tea and the other preparations of nutritious and easily assimilated food, represent the general character of our dietetic resources.

Now, the degree to which this depletory, or stimulant and tonic, plan of treatment should be pushed, will vary with the symptoms, as they are more those of inflammatory or of typhoid fever. As the pulse becomes feeble and rapid, the tongue coated with a brown fur, and increasing debility supervenes, so must the one treatment be exchanged for the other.

It is thus that the *phlegmonous* variety of erysipelas may, in the first instance, require *more* active depletory measures—purgative, diaphoretic, and diuretic salines, with antimony, in doses to touch the pulse, and the occasional use of blue pill or calomel, in slightly cholagogue doses; but these measures must soon be exchanged for a yet *more* free administration of quina with carbonate of ammonia, and a more supporting diet also, than in simple erysipelas.

And again, erysipelas of *traumatic* origin may need yet further support, in proportion to the severity of the injury conjoined with the erysipelas.

Complications, arising from internal inflammations, as meningitis or pleurisy, may be treated in the same way as when these diseases occur independently; due allowance being made for the low character of any such inflammation when associated with erysipelas.

Local Treatment.—Any *repressive* application would be obnoxious; not only as tending to divert the natural course of the disease, in the elimination of the blood-poison, but as possibly repelling the inflammation to some other part, its migration or metastasis being perilous and prolonging the disease. In both these respects, the cutaneous inflammation of erysipelas is analogous to an *attack* of gout.

Warm fomentations by spongio-piline or flannel steeped in a hot decoction of poppy-heads or camomile flowers, and continuously applied, will hasten the termination of the inflammation by resolution. These epithems are also more soothing to the patient than dredging the part with flour or magnesia; a dirty, encrusting, and irritating application formerly in vogue, and still used by some surgeons. Nor can much be said in favour of a strong solution of nitrate of silver,

originally used by Mr. Higginbottom, as an application to the inflamed surface; which, if it fail by its astringent action to induce resolution, may, by over-stimulation, provoke sloughing. A circumferential line drawn with the nitrate of silver, strongly pencilled, was recommended by the late Dr. A. T. Thomson, for the purpose of setting up a sort of incompatible inflammation, and thereby arresting the progress of the erysipelas. But this boundary rarely, if ever, proves a barrier; such at least is the result of general experience; and I now never have recourse to the nitrate of silver in either of these ways.

Phlegmonous erysipelas presents nothing peculiar, otherwise than as pertaining to the subcutaneous cellular texture, which, with the skin, is invariably although secondarily involved. *Free incisions*, and at an *early period*, therefore, fulfil a twofold purpose; as especially advocated by Lawrence. By relieving tension, they may be preservative of the skin, and perhaps of the subcellular texture; both of which are so apt to slough extensively. Moreover, pain is thus relieved, and the inflammation itself moderated by a discharge of blood with the serum effused. It is, indeed, remarkable to notice how the skin speedily loses its purple hue, and becomes almost blanched, as the engorged vessels bleed freely; the patient acknowledging a proportionate mitigation of the pain previously endured. Incisions also facilitate the discharge of pus and sloughs, which to some extent are inevitable. The preventive and curative efficacy of this treatment is now generally admitted; but the number, length, and depth of the incisions are particulars about which differences of opinion exist. Some surgeons prefer one long incision, a practice, however, fraught with probably more danger from shock and hæmorrhage, while it is certainly less effectual for the relief of tension than incisions in different parts. A few cuts—three or four, and of as many inches in length—will be sufficient in most cases. In no case need they be carried deeper than into the subcutaneous slough, which is easily recognized by its ash-grey colour. The treatment subsequently is similar to that of any other suppurating and sloughing wound.

Erysipelas of New-born Infants.—After birth, and for a period of about a month, the new-born infant is still under the influence of the blood derived from the mother, and retains, therefore, all the maternal susceptibilities which are thus entailed. Among these is the liability to erysipelas; in the mother, the source of contagion being the open uterine surface or wound left by detachment of the placenta; while in the infant, the portal of contagion is the open end of the still incompletely obliterated umbilical cord, as originally pointed out by Dr. P. Lorain, and confirmed by Trousseau. Hence, should blood-poisoning arise in the mother and her offspring under these precisely analogous conditions, the local manifestation in the infant, by a diffuse cutaneous inflammation, may be properly designated *puerperal* inflammation.

Commencing insidiously, a red blush appears, usually at the pubes, which rapidly spreads to the scrotum or vulva, down the thighs and up the abdomen; thus extending without fading on the part first affected. Attended with but little febrile disturbance in the first instance, in the course of two or three days, fever supervenes, and which soon assumes the typhoidal character, with gastro-intestinal symptoms of vomiting and diarrhœa, the little patient speedily sinking into a state of fatal collapse. Meanwhile, the inflammatory affection of the

skin and subcellular texture may have subsided into suppurative formations of matter in various parts of the body; or gangrenous patches are not uncommon. Death takes place generally within a week; although the attack may be prolonged for ten days, or even three weeks. Sometimes pus-forming pleurisy or peritonitis complicates the disease, and may hasten the inevitable issue. The low vitality of the new-born infant would not seem to be a secondary cause of death; for, at a somewhat later period—after only the first month of extra-uterine life—erysipelas is not more perilous than in adults. And while, in the one case, no treatment avails; in the other, under the resources of supporting measures, the blood-disease may run its course to recovery.

CHAPTER IX.

PYÆMIA—ICHORRHÆMIA OR SEPTICÆMIA.

The term Pyæmia literally signifies pus in the Blood (πυον, pus, αἷμα, blood); a purulent infection of the blood, and arising, as originally observed, from the local disease known as suppurative phlebitis or inflammation of the veins; that this infection is, generally, soon followed by the formation of secondary abscesses, or at least by deposits of matter, secondary to the primary disease, and which are distributed in various remote organs and parts of the body. But Pyæmia has more recently acquired a far more comprehensive, or a new, pathological signification, as representing also, or instead of purulent infection, three other blood-conditions:—(1) *leucocytosis*, or an increased production of the colourless corpuscles of the blood, which are structurally nearly identical with pus-corpuscles, but which proceed from irritation of the lymphatic vessels and glands; (2) fibrinous infection, more commonly, as arising from the disintegration of fibrinous coagula, or *thrombi*, which had formed within the veins, or arteries, and that the circulation of such matter being arrested in the capillary vessels—a condition known as embolism of these vessels—the fibrinous embolia form metastatic deposits; and (3) the blood infection which arises from the absorption of decomposing animal matter or septic matter, and thence named *ichorrhæmia* or *septicæmia*.

Several kinds of systemic infection, allied or different in their nature, may, therefore, be associated under the generic name of Pyæmia; but, with this understanding, that title may still be retained, subject to whatever differences may have to be mentioned in connection with Septicæmia.

Pyæmia.—*Symptoms.*—A wound suddenly ceases to secrete and discharge pus, becoming drier and glazed, or sloughy; the patient is seized with a concussive rigor or shivering, more or less violent, and lasting for a few moments only, or for some minutes; this is accompanied usually with a sensation of cold, and always with great prostration; the face looks haggard, vacant, and alarmed, as if the person were conscious of some vital injury, the nervo-muscular system responding with a prolonged shudder. Rapid sighing sometimes

completes the picture of prostration. At length the heart arouses, and the pulse rises, even to 150 per minute, beating feebly and irregularly; soon a scorching heat of skin is experienced, and flooding perspiration succeeds. The paroxysm is over. Throughout the course of such an attack, the temperature, as registered by the thermometer in the axilla, undergoes remarkable changes. During rigor, and perhaps before, the temperature actually rises, ranging between 100 and 106 degrees. This increase of heat is exactly proportionate to the severity of the rigor. When sweating begins, the temperature falls, until a lower level is reached. But, although subject to notable fluctuations, it remains uniformly above the normal standard.

Similar paroxysms may recur at periods varying from twelve to thirty-six hours; or at about the same hour for three or four days; or at irregular intervals. Differing in its symptoms and fitful character from an attack of inflammatory fever, the attack as described might be mistaken for an ague fit; but other significant symptoms soon supervene. The breath—as noticed by Berard and Gamgee—has a very peculiar odour, like that of sweetish liver, or of new hay. This, however, is an uncertain symptom, sometimes being absent, or present in febrile disorders which are not pyæmic. But all the secretions show signs of a blood-poison undergoing elimination from the system, albeit ineffectually. The tongue becomes dry, and brown or blackish, while sordes encrustations appear on the teeth and lips. Rank perspiration, often profuse in the sweatings, ammoniacal urine, and a putrid diarrhœa of bilious, serous or mucous, and perhaps blood-stained discharges, alike compete, as it were, incessantly to throw off the poison; but these drains only help to complete the exhaustion. The skin acquires a pallid, muddy hue, or becomes overcast with a dirty-yellow tinge, giving the face and conjunctivæ a jaundiced appearance; and the abdomen may be tympanitic.

Rapid emaciation soon reduces the patient to a shadow; and now —at about the end of a week or ten days—the wound may have regained some secretion, but in the form of a thin, fœtid, purulent fluid; while in the subcutaneous cellular texture of different parts, doughy and scarcely painful swellings may be found, or one or more of the larger joints, as the knees, elbows, ankles, or hips, are swollen and acutely painful, as if attacked with acute rheumatism; but loose fluctuation is perceptible—in fact, the joints affected are full of pus or purulent fluid. Perhaps these *secondary abscesses* have formed in some one or more of the internal organs, and are announced by symptoms peculiar to the organ affected. Thus, with cough, expectoration, and the signs of local pleuro-pneumonia, the lungs will probably be the seat of purulent deposits; or, with pain, especially on palpation, over the region of the liver, and perhaps bilious vomiting or purging, that organ may be suspected; or, with cerebral symptoms and coma, the brain would not be overlooked. Yet the absence of any local symptoms and functional derangement, as compared with what is discovered after death, is often remarkable; the viscera seeming to tolerate secondary abscesses, without much disaffection. The patient, who had been restless and sleepless, as in all febrile disorders, sinks into a low muttering delirium, and at length into a comatose state; or death takes place from sheer exhaustion, the prostration from pyæmic blood-poisoning is so overwhelming.

Instead of this typical and marked form of infection, an irregular and less pronounced manifestation of the disease is not uncommon. The wound may have undergone no morbid change, remaining in a state of healthy suppuration; no rigors, or pyæmic shudder, may have announced the attack; but there is an insidiously increasing rapidity of pulse, and pungent heat of skin, alternated by sweats, with utter prostration, and thus the patient sinks.

> "The life of all his blood
> Is touched corruptibly; and the pure brain
> (Which some suppose the soul's frail dwelling-house)
> Doth, by the idle comments that it makes,
> Foretell the ending of mortality."

Pyæmia is not always fatal. Sedillot and Vidal have recorded cases of recovery. Nélaton dissents, and affirms that death is inevitable. It takes place usually about the tenth day; sometimes earlier, as the third day; or, much later—six or seven weeks. According to the duration of the disease, pyæmia may be designated *acute* or *chronic*.

Secondary abscesses.—Post-mortem examination reveals numerous abscesses in one or more organs and textures of the body; and they are not inaptly termed *secondary*, when subsequent to an abscess, or at least to suppuration, in some other part. Secondary abscesses most frequently occur in the lungs and liver. Their general characters are these:—In several portions of the organ affected, black blood has accumulated; such portions are indurated, brittle and easily break down under slight pressure of the finger; the texture is congested and disintegrated, forming the red *infarctions* so named by continental pathologists. Some of these disintegrated portions present a yellow spot of pus in the centre of the black mass, in other parts pus has altogether supplanted the blood and disintegrated textures; and these *pus-deposits* are tolerably circumscribed—in fact, abscesses are then formed, each surrounded with a dark margin of congested texture. Mr. Lee states that the central spot of each affected portion at first consists of lymph, which gradually extends towards the circumference. If the disease continue, these spots suppurate, the affected portions having previously softened and disintegrated in the same order in which they were primarily solidified. Secondary abscesses are usually of a small size, in the viscera varying from a pin's head to a walnut, very numerous, and of rapid formation, a few days sufficing for their development in many organs. Although most commonly found in the lungs and liver, other organs and tissues are not exempt. They occur elsewhere—approaching the following order of frequency—in the spleen, brain, kidneys, heart, skin, mucous membranes, within serous and synovial cavities, in the muscles and cellular tissue, and in the eye; in the prostate (Gamgee).

The *diagnosis* from primary abscess is twofold. It will be observed that the chosen seat of an ordinary or primary abscess—the cellular texture—is not the usual habitation of secondary abscesses; and usually there are no local symptoms—no pain, or functional derangement, although certain parts—as the lung, pleura, peritoneum, and intestinal canal—will not tolerate secondary abscesses without some local symptoms of disaffection. It may also come to pass that death ensues from coma, asphyxia, or from necræmia as the result of further

blood-poisoning accruing from the non-elimination of various excrementitious matters.

The blood itself has undergone serious changes of chemical composition, probably; of physical properties and vital endowments, certainly. It has less plastic power, coagulates imperfectly and less readily. Hence, the more fluid blood is apt to transude, minute hæmorrhages take place in various textures, and the gastro-intestinal mucous membrane is stained with a reddish tint. Pyæmic pus often appears in the form of a thin, sanious, or oily fluid, abounding with exudation corpuscles, and characterized also by a proportionate absence of pus-cells; but the chemical composition of this fluid has not been found to differ from that of healthy pus.

Septicæmia is manifested by essentially the same symptoms,—prostration, coma or delirium, with profuse rank perspiration and diarrhœa, all which indicate the operation of some blood-poison, and apparently the secretive effort of nature to eliminate it. But, according to Billroth's description of septic poisoning, the initial chills, with increased temperature, are very rare, and they never occur in the course of acute septicæmia; later in this disease, the temperature falls to the normal standard, or even below it. The pulse dwindles down to a mere thread, and in a state of perfect collapse, the patient dies in twenty-four hours, although life may be prolonged for a week or two. Death may occur in an early stage, with rising temperature. Sometimes the disease runs its course with an abnormally low temperature, especially in enfeebled or aged persons.

After death, the subcutaneous cellular texture is often found infiltrated with bloody serum, or purulent matter, accompanied with gangrene of the skin in parts. But the internal organs are usually free from secondary abscesses, although congested and softened as in most blood-diseases. Peyer's glands in the ileum and jejunum may be swollen, when there had been profuse diarrhœa; and perhaps the serous membranes exhibit sero-purulent effusions, as from a low form of pleuritis and pericarditis. The blood—as, for example, in the cavities of the heart—is in a state of imperfect coagulation, consisting of sizy clots, or fluid, like treacle. No peculiar morbid alterations are found in the composition of the blood.

Septopyæmia is so named by Heuter, to denote a mixed state of infection, arising from the entry of *decomposed* pus into the circulation, and attended with a combination of the symptoms of septicæmia and pyæmia. But while the distinction of these states of infection is often impracticable, their admixture cannot be recognized as a separate disease.

Pathology of Pyæmia.—Having stated the leading facts relative to pyæmia as at present known, and its local consequences; what is the nature of the blood-condition or systemic infection, and what is its relation to the formation or production of the secondary abscesses?

First, as to the nature of the blood-condition. The several kinds of infection, already alluded to, have been more or less accredited by different observers. (1.) *Purulent* infection.—The circumstances under which pyæmia arises would lead to the *inference* that during life *pus* itself, as *bonâ fide* pus, has entered the circulation, either by suppurative inflammation of the veins, occasionally of the lymphatics, rarely of the arteries; or by absorption through the veins, aided by

the lymphatics, laid open and exposed by mechanical injury, as by wounds, or rapid sloughing of the suppurating part; and that the pus thus produced within vessels, or introduced from without, possibly circulates with the blood, inducing secondary deposits.

Suppurative Phlebitis.—Hunter originally observed, that "in all cases where inflammation of veins runs high, or extends itself considerably, it is to be expected that the whole system will be affected. For the most part, the same kind of affection takes place which arises from other inflammations, with this exception, that where no adhesions of the sides of the vein are formed, or where such adhesions are incomplete, pus, passing into the circulation, may add to the general disorder, and even render it fatal."

Nearly all subsequent observers confirmed Hunter's theory of pyæmia as thus indicated; that suppurative phlebitis having occurred, the entry of *pus* into the circulation is the immediate cause of systemic infection. Cruveilhier came to the conclusion that pus is transmitted from the veins in which it is formed; and his observations of the stages of suppurative phlebitis seemed to establish two facts. Firstly, when pus produced within a vein is excluded from the general circulation, as by a barrier of coagulated blood, or by adhesion and obliteration of the vein, no symptoms of pyæmia ensue; secondly, when the obstruction is removed, the symptoms of pyæmia immediately commence. The unavoidable inference is, that pus is carried from within the suppurating vein into the general circulation.

It would appear that pus is first formed, not between the vein and the clot, but in the very *centre* of the coagulum, which soon blocks up an inflamed vein. The symptoms of pyæmia do *not* arise *then*. But the proportion of coagulum diminishes, while that of the pus increases, and this may take place here and there in the course of the vein, as the inflammation is more or less advanced, thus presenting adhesive, alternating with suppurative, phlebitis. Usually, adhesion limits and *circumscribes* the suppuration; and *then*, also, the general mass of blood, in circulation, remains uncontaminated. In a more advanced stage, the distended vein becomes knotty at the various parts where pus has accumulated; the vessel bursts, and partly discharges such matter into the adjoining cellular texture, forming abscesses; but, when the dyke made by the clots is *broken down*, being removed by absorption, pus is transmitted into the circulation, and *then* pyæmic symptoms immediately commence, announced by violent rigors, and soon proceed to a fatal termination.

This interpretation of pyæmia, as the consequence of suppurative phlebitis, was supported, apparently, by the observations of most pathologists, British and foreign; and whose writings were specially referred to in the former edition of this work.

Others have denied the possibility of pus entering the circulation under the ordinary circumstances of suppurative phlebitis. Tessier alleges that at *all* stages of venous inflammation the pus is *enclosed* in the cavity of the vein by clots or false membranes, and that at no period of the anatomico-pathological existence of phlebitis, is its entrance into the blood possible. Mr. Lee appeals to the results of experiments on blood out of the body. He urges that the simple experiment of mixing some pus with healthy, recently drawn blood, will at once show that such a combination cannot circulate in the living

body. It will be found that the blood *coagulates* round the globules of pus, and forms a solid mass which will adhere to the first surface with which it comes in contact; and it will be evident that it is not till the coagulum thus formed is broken up or dissolved that its elements can circulate with the blood. But Mr. Lee's inference from his "simple experiment" *assumes* that that which is true of blood mixed with pus *out* of the body, is also true of blood *circulating* with pus *in* the *living* body. The inference drawn breaks down, because the circumstances of the two cases are so essentially different. This, as Hunter said, is "putting living and dead animal matter upon the same footing, which is a contradiction in itself."

The real *objections* to Cruveilhier's theory may be gathered, partly, from the *process* itself, described as phlebitis, advancing to suppuration. That the initial change is not in the coats of the vein affected, but consists in the formation of a *coagulum* within the vessel; that the pus, so called, does not proceed from the interior of the vein, but appears in the *centre* of the clot; and that only when this pus-like matter, from within the *coagulum*, enters the circulation, pyæmic symptoms supervene. To these facts may be added the positive evidence supplied by microscopic examination; that this pus-like material is simply disintegrated fibrin, which has thus become changed into granular matter; a fluid, having the yellowish colour and consistence of pus, but not containing cellular elements, which are essential to pus; in other words, it is—as Virchow expresses it—a puriform, but not a purulent, fluid. Sometimes, however, cells, like pus-corpuscles, are found associated with the granular fibrin; but these cells *pre-exist* within the clot, they do not originate therein, nor come from the adjoining coats of the vessel. Recent coagula are found to contain such corpuscles heaped up in masses, and which are set free by disintegration of the enclosing fibrinous coagulum. These cells are, in fact, the pale corpuscles of the blood, which are now known to be identical with pus-corpuscles in appearance; and their pre-existence within the substance of the intra-vascular clot, explains what would otherwise seem to be the production of pus. What becomes of the red corpuscles? They shrivel up, lose their colouring matter, and disintegrate with the fibrin; presenting a yellowish, instead of a reddish, puriform fluid.

Bearing in mind this series of changes in the fibrinous coagula, and the enclosed blood-corpuscles, pale and red, we perceive how the whole process of disintegration, with perhaps the appearance of pale blood corpuscles, was mistaken for pus-production; although even then, the twofold fact of its occurrence, in the centre of a coagulum, and that clot-formation was the initial change within the vessel, might have corrected the misconception as to the nature of this process. Moreover, it is alleged, as the result of experimental observations, that no exudation can be produced within a vein, when the blood-stream is prevented from passing through it; thus apparently disproving the possibility of phlebitis having any such result. Virchow does not deny the possibility of a real phlebitis, and that it may advance to suppuration; but that it is an inflammation which affects the walls, and not the contents, of a vein; and that even abscesses may form, which cause the wall to bulge on both sides like a variolous pustule, without any coagulation of the blood ensuing in the cavity of the vessel. Sometimes, however, phle-

bitis leads to the formation of inequalities upon the inner wall, which favour the production of a coagulum, and thence the series of changes already described; possibly also, in consequence of the fibrinous disintegration extending laterally to the wall of the vessel, phlebitis may be induced,—the wall becoming cloudy and thickened from the interstitial deposit of exudation-matter, followed perhaps by suppuration, but within the substance of the wall.

Suppurative Lymphatitis.—Inflammation of the lymphatic vessels, advancing to intra-vascular suppuration, is another accredited mode of pyæmic infection; by the transmission of pus through these vessels, and the lymphatic glands, thence into the venous circulation. But, in objection to this interpretation of pyæmia, may be urged the apparent impossibility of pus-corpuscles finding their way through a lymphatic gland; owing to the fact that the lymphatic vessels in the gland, having divided into yet smaller vessels, enter into spaces which are filled with cellular elements; thus offering an insurmountable obstruction to the passage of pus-corpuscles. Enlightened, however, by our present knowledge respecting the amœboid activity with which pus-cells are endowed, this difficulty would appear to be questionable. But Virchow, who adduces the anatomical argument here referred to, enforces it by an experimental observation as to the effect produced in the proximate lymphatic glands, by the absorption of insoluble colouring matter, after tattooing some distant part, say the arm, with gunpowder or cinnabar. The lymphatic vessels transmit, in the current of lymph, molecules of such matter, which are smaller than even the smallest pus-corpuscles, but which are always arrested and deposited in the nearest group of glands; as shown on section. It is further alleged, that any irritation of the lymphatic glands, in connection with suppurative lymphatitis, will give rise to an increased production of lymph-corpuscles; thus inducing a blood-condition which cannot be distinguished from the apparent admission of pus-corpuscles,—*leucocytosis*, as if pyæmia.

Arteritis rarely advances to apparent suppuration, and more rarely are there any consequent symptoms of pyæmia. But now and then, utter prostration, with an incredibly rapid pulse, suggest this inference; and the oppressive delirium of pyæmia speedily closes the scene. Such cases may be instances of capillary embolism, arising from the disintegration of a fibrinous clot in the inflamed artery, fragments of which matter being carried in the blood-stream, are arrested in the capillary vessels of various organs, as the kidney or spleen, forming metastatic deposits therein.

Suppurative phlebitis, suppurative inflammation of the lymphatics, and possibly, suppurative arteritis, are not the only *apparent* sources of pyæmia,—the immediate cause being the *direct* transmission of pus from the vessels in which it is formed into the general circulation. Precisely the same constitutional disorder frequently follows the *absorption* of pus from suppurating surfaces, as wounds and sores. Velpeau, Maréchal, Rochoux, and others have attributed pyæmia solely to absorption, and in such cases.

What are the particular circumstances which allow the absorption of pus from a suppurating surface, so as to induce pyæmia? It is well known that pus may be absorbed from an abscess without pyæmia ensuing, the pus-corpuscles having previously undergone a fatty

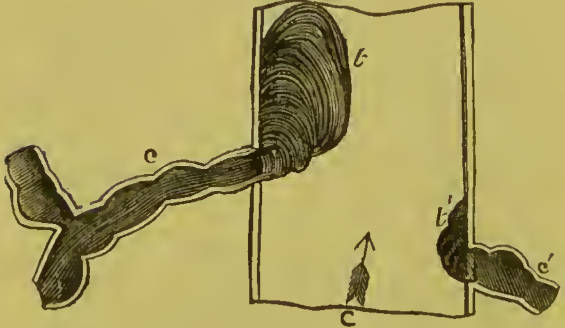
transformation and disintegration into granular matter; and Cruveilhier himself pointed out the important distinction between the absorption of pus when *prepared* for absorption, and pus in the condition of pus, at once entering the circulation. In the former case, no constitutional disturbance follows; in the latter, pyæmia. To allow of the absorption of pus in an *unaltered* condition, the *absorbing vessels* must have been laid *open;* the veins, lymphatics, or both, must have undergone solution of continuity; and this, either by a wound without subsequent repair, or by rapid sloughing, without time for closure of the vessels by the adhesive process. They therefore remain open during suppuration, and their mouths—so to speak—being in immediate contact with pus, allow of its admission and transmission.

This mode of purulent infection accords with Mr. Liston's observation, that "when from any cause the extremity of a large vein in a wound is not closed—when it is not plugged up by plastic matter, pus seems to enter it readily, and by mixing with the circulating fluid, causes dreadful mischief. Great constitutional disturbance accompanies the purulent deposits which follow in the solid viscera and in the joints." In other cases these results are preceded by rapid sloughing. A wound suddenly loses all power of healing by adhesion, and any adhesions that may have formed give way, the granulations become pale and flabby, and true pus is no longer discharged; the surface acquires a mottled brown colour, and by this time symptoms of pyæmia have commenced. Burns, attended with extensive suppuration, are not unfrequently followed by pyæmia; and certain specific diseases, as glanders, in like manner, threaten purulent infection by absorption. Occasionally, suppurative phlebitis advances so far as to allow of absorption through a vein having burst, and opened into an abscess. In one case, the femoral, popliteal, posterior tibial, and peroneal veins communicated with abscesses (Cruveilhier). In another case, the internal jugular vein opened into a neighbouring abscess (Travers).

(2.) *Thrombosis—Leucocytosis—Ichorrhæmia* or *Septicæmia.*—These three pathological conditions are here grouped together, as representing—according to Virchow's observations—the different sources and kinds of blood-infection, which severally, or in association, constitute what is commonly called Pyæmia; a condition, therefore, which may be complex, and certainly is not thus regarded as one of *purulent* infection.

Thrombosis.—A Thrombus, consisting of fibrinous coagulum, formed within a vein, is liable to undergo softening and disintegration; and fragments of variable sizes, entering the blood-current (Fig. 80), are carried in the course of the circulation, through the larger veins issuing in the vena cava to the right cavities of the heart, and passing thence into the pulmonary artery, they may become

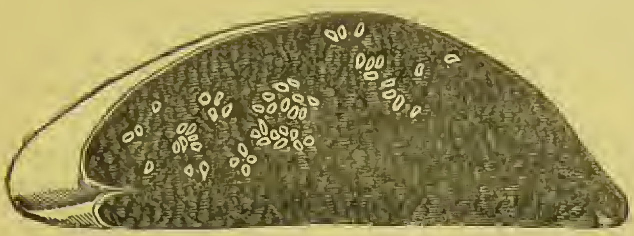
FIG. 80.*



* Diagram, from Virchow.

arrested and impacted in the pulmonic capillaries, or in the portal capillaries of the liver (Fig. 81), thus, and there forming *metastatic deposits.* To this process of fibrin-transference, and impacted state of the vessels, Virchow gave the name of *Embolism ;* while any such impacted blood-clot, thus transferred, is named an *embolus* or *embolon.*

Fig. 81.*



But disintegrated fibrin, as derived from the breaking down of a thrombus, consists of granular matter, and not of cells; however much, therefore, this material may resemble pus in its physical characters of yellowish-opaque colour, and milky or creamy consistence, it is not a purulent fluid, although puriform. Moreover, as Virchow has shown, a similar process of fibrin-transference and embolism may take place in the arterial system; from fibrinous coagulum having formed in the heart, or thrombosis in an artery; and which, therefore, must be quite independent of any phlebitis, suppurative or otherwise. Billroth qualifies Virchow's theory of fibrin-transference, by the apparent fact that a thrombus may be actually converted into pus, in virtue of the contained white blood-cells, just as pus is formed from cells wandering out of the vessels. When also a disintegrating thrombus has imbibed any purulent, or perhaps putrid matter, as from an adjoining wound, embolic fragments carry with them such matter, and thus generate metastatic abscesses. In this way—if the matter be putrescent—there will be a combination of septicæmia with the pyæmia, properly so called.

Leucocytosis signifies an increased quantity of the pale corpuscles in the blood, which having a close structural resemblance to, or identity with, pus-corpuscles, it becomes impossible to recognize pyæmia as pus in the blood. Dr. Hughes Bennett, who originally discovered this white-celled blood, described it as suppuration of the blood. Leucocytosis may arise from any local irritation of the lymphatic glands and vessels.

Ichorrhœmia or *Septicœmia* denotes that infection of the blood which proceeds from the absorption of ichorous or putrescent animal matter; whether generated in a wound, or inoculated.

Septicæmia has more recently been investigated experimentally by Weber of Bonn, and Polli of Milan; animals having been subjected to septic blood-poisoning by the injection of putrescent animal matters into their circulation. The latter observer regards septicæmia as a true *fermentation* of the blood, induced by the action of living organisms, as bacteria and vibriones. Sulphites of the alkalies, or alkaline earths, seem to have a safely prophylactic influence, in being anti-fermentative, without having any poisonous or corrosive action.

(3.) *Miasma.*—The production of what appears to be pyæmic infection is sometimes referred to the importation of germs or minute living organisms, dried pus dust, or other organic matter, emanating from wounds. This view is suggested by the fact that pyæmia commonly arises in Hospitals when and where many wounded patients lie crowded together, and in close wards; aggregation and deficient ven-

* Museum of St. Bartholomew's Hospital.—A drawing.

tilation seeming to develop, as well as facilitate, the transmission of the contagious matter in the atmosphere. On the other hand, in wards not crowded, and freely ventilated, although occupied with wounded patients, pyæmia is uncommon. According to Lücke's observations, blue-coloured pus abounds with organic germs, which are infective to other wounds; and this colour is not inherent in the pus as it comes from a granulating surface, but is developed in the absorbent lint or other dressing.

Billroth, among other clinical observers, advocates the miasmatic origin of pyæmia; and I must confess that my own experience entirely accords in its probability, although not as the only mode of causation. At the Royal Free Hospital, under the favourable hygienic conditions of space and ventilation, coupled with yearly removation of the wards, weekly scrubbing of the floors, frequent change of the bedding and linen, and scrupulous cleanliness in the dressings of wounds, without any employment of sponges as a medium of inter-communication, pyæmia very rarely occurs. Regarded as the offspring of the contrary adverse conditions of hygiene, pyæmic infection is associated with other diseases of blood-poisoning, which together have sometimes received the name of "Hospitalism." This position is, however, the subject of much disputation. As the general outcome of a long discussion at the Clinical Society of London, 1874, the question having been raised by an able address from the president, Mr. Prescott Hewett, it would appear that pyæmia is relatively as frequent after operations in private as in hospital practice; but this estimate was gathered more from the impressions of experience than from any sufficiently large collection of authentic cases, compared with those in Hospitals. For my own part, I cannot accord much weight to any such comparison; external circumstances alone being considered, while the influence of individual predisposition is necessarily unknown. As in the production of other blood-diseases, the development of pyæmic infection depends not only upon the seed sown, but also, and perhaps principally, upon the nature of the soil in which it is implanted; and respecting this element in the estimate, we are altogether ignorant.

Formation of Secondary Abscesses.—The mode of production of secondary abscesses, in various and remote organs and parts of the body, in consequence of purulent infection of the blood, is doubtful. It may be by the arrest, and actual deposition, of pus in the capillaries of the parts affected, conveyed there through the circulation—the theory originally entertained; or, that the arrest of pus, or of disintegrated fibrin, in these vessels, induces suppurative inflammation—phlebitis—of the smaller veins, as suggested by Cruveilhier.

CAUSES.—(1.) *Predisposing.*—Certain causes appear to favour the production of blood-poisoning, whether pyæmic or septicæmic. They are all of an enfeebling character, and are referable to the constitutional condition, habits, and hygienic circumstances of the individual infected. Thus may be enumerated, exhaustion, consequent on prolonged illness, and especially from blood-diseases, as typhoid fever, or in certain organic diseases, as degeneration of the kidneys with albuminuria, and phthisis; or exhaustion, increased by the shock of injury or surgical operation, as from compound fracture or amputation; mental depression also is another such predisposing condition; while parturition, when difficult or tedious, induces a peculiar liability.

The habitual indulgence in alcoholic liquors is said to be specially prejudicial. Hygienic circumstances chiefly include impure air from overcrowding of patients, want of cleanliness in the dressing of wounds, defective drainage, deficient ventilation, and the relative influence of heat and cold on the decomposition of animal matter. Age and sex have apparently no particular relation to the liability of pyæmic or septicæmic infection.

(2.) *Exciting Causes*, and *their Operation*.—*Injuries* and *surgical operations* attended with much suppuration, are well known to threaten pyæmia; and they may do so, perhaps, *partly* by absorption of pus, and *partly* by suppurative inflammation of the disorganized veins. Compound fractures may thus occasion purulent infection; and injuries of the head probably operate chiefly by suppurative inflammation of the veins of the diploe. Dance first suggested this explanation; Cruveilhier gave the anatomical proof by dissection,—according to his theory. Indeed, the latter observer affirms that phlebitis of bones is one of the most frequent causes of visceral abscesses, from wounds and surgical operations implicating the bones. The mere removal of a necrosed bone is sometimes followed by pyæmia; but whenever destruction of the osseous texture, accompanied with suppuration, is followed by pyæmic infection, absorption of pus probably has been partly the cause, its absorption being determined by the anatomical condition of the veins, which are kept open by the bony channels through which they pass. Amputations of the limbs, of the breast, lithotomy, and the operation for fistula in ano, likewise threaten pyæmia, when suppuration is abundant. Absorption and suppurative phlebitis may co-operate in these cases to infect the blood with pus. They assuredly co-operate in pyæmia following venesection. The vein is punctured, and the aperture absorbs pus, subsequently diffused around the vein; while the vein itself, having suppurated, transmits pus into the general circulation. Probably, suppurative inflammation of the lymphatics contributes to pyæmia, in some cases where and when absorption of pus may have taken place. A faint blush in the course of the lymphatics frequently supervenes on the sudden cessation of a purulent discharge; forthwith pyæmic symptoms commence; eventually the lymphatic vessels appear as red lines ramifying from the sore, becoming harder and more painful —more inflamed, in fact—as pyæmia advances. Pyæmic infection, thus read in the light of purulent absorption from suppurative phlebitis, consequent on wounds, may also be interpreted according to the other modes of pathogenesis already noticed; thrombosis, leucocytosis, septicæmia, and miasmatic infection.

Prognosis.—The course of pyæmic infection is generally to a fatal termination. But our prognosis will be more or less unfavourable according to the *acute* or *chronic* character of the disease. The more frequent the rigors, and more rapid the prostration, and the earlier secondary abscesses supervene, death will be more certain and speedy. When the progress of the symptoms is slower and less marked; when also the fever subsides for some days, and the wound begins to regain a healthy appearance; then, recovery is more hopeful. In septicæmia, the prognosis will be guided by similar considerations.

Treatment.—*Preventive* measures consist in the rigorous observance of hygienic precautions, especially with regard to cleanliness in dressing wounds, free ventilation, and the avoidance of any crowding of patients

in Hospital wards. Hæmorrhage should be arrested, and inflammation subdued; and any collection of blood or pus prevented or at once evacuated. Antiseptics, such as carbolic acid and chlorine solutions, may be used, but their prophylactic agency is an open question. Pyæmia is scarcely amenable to any *remedial* measures. Stimulants and tonics, with as much nutritious and readily assimilated food as can be taken, constitute the only plan of treatment for probably sustaining the patient through the dread exhaustion which must be undergone, even when recovery ensues. Thus, wine, brandy, or as brandy-and-egg mixture, strong beef tea, ammonia and quinine—in large doses, as four or five grains—may be administered repeatedly, every three or four hours. Opium has a marked beneficial influence in controlling the rapidity of the pulse, and the general irritability associated with prostration. Creosote seems to have some corrective influence on the putrid intestinal discharges. The natural excretion of a blood-poison might apparently be promoted by laxative aperients and sudorifics, especially the warm bath; but the profuse diarrhœa and sweating in the course of pyæmia both tend to increase the exhaustion; and the remedial efficacy of any eliminative measures, hitherto tried, is also very doubtful. Cleanliness in the dressing of a wound, and free ventilation, must still be observed. But amputation, for the removal of the source of infection, will rarely succeed in arresting the course of pyæmia. I have tried this resource, and failed, even immediately after the incipient rigors. *Secondary abscesses*, when tense, and in any superficial or accessible part, may be opened; and by a valvular incision, as in the treatment of a chronic abscess, so as not to admit air to the readily decomposing purulent collection.

CHAPTER X.

HOSPITAL GANGRENE.

Hospital gangrene is fortunately known to but few surgeons in civil practice now living; and we must refer to those of the past for information. The shortcomings of personal observation are, however, amply compensated by the testimony of many witnesses on record; for a disease so formidable has ever been watched with deep interest whenever it occurred. From *original* sources of information, therefore, we are enabled to identify this disease, while its etiology suggests appropriate preventive measures. Hospital gangrene has received various other names; not because of any doubt respecting its pathological nature, but as expressive of its various characters, and mode of origin. Thus, Pulpy Gangrene, Phagedænic Gangrene, Sloughing Phagedæna, Putrid Ulcer, Pourriture des Hôpitaux, Contagious Gangrene, Hospital Sore, and Diphtheria of Wounds, are severally synonymous.

Signs, and Diagnostic Characters.—Overlooking the many phases of this gangrene, and regarding only its more constant phenomena, its nature is perhaps best expressed by denominating it, *essentially, gangrenous* inflammation; that is to say, inflammation certainly, but inflammation passing at *once* into gangrene, thereby appearing only a process of textural disintegration. Sometimes the process of destruc-

tion resembles more that of phagedæna, alternating with rapid sloughing; so that the worm-eaten phagedænic surface suddenly becomes a large slough, and then again phagedænic. These different aspects of the disease are apt to mask its really gangrenous character. What, then, are the phenomena more constantly observed? Acute pain, sudden engorgement and bloated swelling, dusky-red discolouration around the doomed part, and conversion of its textures into a putrid glutinous or slimy slough, exhaling a peculiar fœtid odour. Rapidly extending, all the soft textures are soon melted down, leaving only the bones staring, of an ebony black,—as if the rafters of a house where a fire had raged.

These *general* characters are clearly visible in the portraits of this disease, drawn by eye-witnesses; varied, however, by special circumstances; principally, by the previous kind of injury to the part affected, the textures engaged, and the constitution of the individual.

Origin and Course.—To identify this gangrene under the modifying circumstances referred to, it is necessary to trace its origin and progress—in a stump after recent amputation, as an incised wound, or granulating as an ulcer, a recent gunshot wound, a small puncture, an old sore, and lastly, a blistered surface.

For the particulars of these six aspects of Hospital Gangrene, I avail myself, chiefly, of Blackadder's original and valuable treatise.

(1.) When a *stump* is affected, and the patient has a plethoric habit, or is accustomed to live freely, intense inflammatory action soon runs through its whole substance; swelling rapidly increases, so that in a few days the stump acquires more than twice its former size, and being much indurated, occasions the most excruciating pain. In this state the patient may become delirious, and die suddenly by effusion into some of the larger cavities. More frequently, however, gangrene seizes upon the integuments and cellular texture, large sloughs are thrown off, and some of the larger blood-vessels giving way, the patient sinks under the exhaustion of repeated hæmorrhage. Sometimes the progress of the disease in a stump is more *gradual*, yet ultimately nearly as fatal. Inflammation is much less acute—there is comparatively little tumefaction, and the pain is far less severe; but the discharge is much more copious, and the cellular texture connecting the integuments and muscles is rapidly destroyed. Hæmorrhage generally supervenes later than in the preceding instance; it is, however, the most common cause of death. Sometimes a stump, almost soundly *cicatrized* to all appearance, will suddenly burst open and fall into gangrenous disintegration. Such cases are well described by John Bell. In one day he saw three stumps burst open, each of which had so nearly cicatrized, that you could have covered the small spot remaining unhealed with the tip of the little finger.

When this gangrene supervenes after any amputation, the case may be regarded as that of an *incised wound*, healing probably by adhesion, but suddenly diverted from primary union, and undergoing the aforesaid process of destruction.

(2.) Observe the same gangrenous inflammation supervening on a healthy *granulating* wound, or ulcer. The ulcer becomes painful and swollen, loses its healthy florid appearance, while the granulations, which were small and distinct, become flabby, and in some cases appear as if they were distended with air; in others, vesicles containing a

watery fluid or bloody serum, have been observed, and the sensation in the sore has been described as resembling the sting of a gnat. The secretion of pus is arrested, and the surface is covered with a tenacious viscid ash-coloured matter, which adheres firmly. After some time a discharge of thin ichorous matter ensues, a very peculiar cadaverous febrile smell, the pain increases, the edges of the sore are reverted, and generally assume a circular form; an erysipelatous redness encircles it, extending possibly to a great distance, even over a whole limb; the neighbouring glands, as those of the axilla or groin, swell, inflame, and perhaps suppurate. This diffuse inflammation goes on apace, thin ichor continues to be discharged in great quantity, and a thick slough, apparently of coagulable lymph, like melted tallow, covers the whole surface of the sore; the fætor is intolerable and the pain insupportable. At last an oozing hæmorrhage soaks the dressings, or a larger blood-vessel having sloughed, robs the patient of his last remaining source of strength, and the typhoid constitutional commotion soon terminates in death. Blackadder noticed that when the disease attacks a *large* recent wound, its whole surface may be affected at once; while in other cases, the gangrene commences on, or near, the lips of the sore.

(3.) Passing from incised to *contused* wounds; when the disease attacks a *recent gun-shot wound*, the discharge, two or three days after contagion, is found to be lessened, and to have become more sanious than purulent. The sore has a certain dry and rigid appearance, its edges are more defined, somewhat elevated and sharpened, and the patient experiences in it a stinging sensation, as if occasioned by a gnat. Then, or a day or two later, the integuments at the edge of the sore become inflamed, and the surface of the sore itself assumes a livid or purple colour, and appears covered with a fine pellicle, such as forms on coagulating blood.

(4.) As attacking a *puncture* or scratch, "the first appearance of hospital gangrene resembles that of a part inoculated with *vaccine* virus." The primary inflammation begins at the end of the second, or early on the third day; it reaches its height about the sixth; but when the scab begins to form in one disease, *phagedænic* ulceration begins in the other, and if allowed to proceed soon affords sufficient proof of the non-identity of these diseases.

(5.) Should the disease attack an *old sore*, where a considerable depth of new texture has been formed, a vesicle arises, filled with a livid or brownish-black fluid, which bursts and assumes the appearance of a small dark-coloured spot. Such vesicle, or spot, is usually situated at the edge of the sore. Phagedænic ulceration, spreading therefrom, makes comparatively very slow progress through the surface-bed of new texture, but having reached the subjacent natural texture, its progress is suddenly accelerated, acute inflammation supervenes, and a large slough forms.

(6.) Lastly, when attacking the skin from which the *cuticle* has been *removed*, as by a blister, one or more small vesicles first appear, filled with a watery fluid, or bloody serum of a livid or reddish-brown colour. The situation of this vesicle also is generally at the edge of the sore. Its size is not unfrequently that of a split garden-pea, and it is easily ruptured, the pellicle which covers it being very thin. If the vesicle contain a watery fluid, and has not been ruptured, its appearance resembles a greyish-white slough; if containing a dark-

coloured fluid, or when ruptured, it appears a thin coagulum of blood, of a dirty brownish-black colour. During the formation of the vesicle a painful sensation in the sore is generally experienced, like that of a gnat stinging.

Thus the earliest and most elementary phase of Hospital Gangrene may be *vesicular;* just as gangrene generally begins, the senile gangrene in particular. The features peculiar to, and characteristic of, this so-called Hospital Gangrene, ensue *subsequently*—its slimy slough, its rapid progress, its appalling devastation. I shall presently have to notice one character which foretells all the rest, I mean *propagation* by *contagion*, and possibly by infection also, whereby the disease runs through a whole ward—a whole hospital if unchecked—passing from bed to bed with the rapid strides of death.

The *local results* to be anticipated are always sad, sometimes shocking. Among Blackadder's cases; in one, half of the cranium was denuded, the bones were black as charcoal, the integuments detached posteriorly to the second cervical vertebra; anteriorly, to the middle of the zygomatic process of the temporal bone; and this was originally only a superficial scalp wound. In another case, the integuments and cellular texture, on the anterior parts of the neck, were destroyed, and the trachea laid open, presenting a horrid spectacle. Among John Bell's cases, in one, the skin and muscles were carried away from the shoulder down to the bellies of the supinator muscles; and eventually, when the sloughing terminated, nothing seemed to be left of the arm except the bone, covered with a velvet-like surface of shining red flesh; and this was originally only a narrow splinter wound on the middle of the outer side of the arm. Continuing our course down the body; in one case, a very slight and superficial wound of the thigh grew into a sore, at first no bigger than the palm of one's hand; in two days as large as the crown of a hat; and in a week the whole skin of the thigh was destroyed, the muscles were stripped of skin and fascia from the hip to the knee, the trochanter was almost laid bare, the hamstring muscles were exposed to a considerable extent, and all the muscles of the thigh dissected in a manner which no drawing could express. With even these cases in view, imagination will scarcely realize the ravages of this gangrene. A tattered skeleton, still held together by ligaments? No; for the joints may be laid open extensively, and the knee, ankle, elbow, or wrist disarticulated.

Constitutional Disorder.—Long before any such irreparable injury has been inflicted, the constitutional powers take affront. The period, however, at which the constitution begins to exhibit symptoms of irritation is extremely irregular, sometimes as early as the *third* or *fourth* day, sometimes as late as the *twentieth*. The countenance assumes an anxious or feverish aspect, the appetite is impaired, thirst succeeds, and the tongue is covered with a white mucus. Some constipation prevails at first, which ends in diarrhœa. The pulse is rather irritated than accelerated. The general symptoms, however, have an inflammatory or typhoid character, according as the causes of either predominate. When an *inflammatory* diathesis prevails, the system becomes gradually more irritated, until acute inflammation attacks the sore, an event that frequently happens about the end of the second week. At this period the pulse is frequent and sharp, and not uncommonly the patient has one or more shivering fits, suc-

ceeded by great increase of heat, seldom or never terminating in a profuse perspiration. The cold fit is sometimes followed by a bilious intestinal evacuation, with mitigation of the febrile disorder. If the local mischief be not arrested, weakness increases daily to exhaustion; the fever loses its inflammatory character, and unless the patient be cut off by hæmorrhage, he falls a victim to extreme debility. When the disease has a *typhoid* character, the pulse is small and frequent, the appetite and strength gradually fail, not unfrequently diarrhœa supervenes, and the patient at length sinks, retaining his mental faculties to the last.

Causative Relation of the Local and Constitutional Conditions.—Whether does the constitutional disorder or the local disorganization precede? What is the order of succession; which is the cause; which the effect? Surgeons are nearly equally divided on this question; but the weight of experience decidedly preponderates in favour of the *local* origin of hospital gangrene.

(1.) *Local Origin.*—Blackadder affirms—that in no single instance which he had an opportunity of observing, did the constitutional symptoms precede the local; unless the case be held an exception, where a stump became affected after amputation had been performed, on account of the *previous* effects of the disease.—That the morbid action could almost always be detected in the wound or sore previously to the occurrence of any constitutional affection.—That in several instances the constitution was not affected until some considerable time after the disease had manifested itself in the sore.—That when the disease was situated on the lower extremities, the lymphatic vessels and glands in the groin were observed to be in a state of irritation, giving pain on pressure, and were sometimes enlarged before the constitution showed evident marks of derangement.—That the constitutional affection, though sometimes irregular, was in many cases contemporary with the second, or inflammatory stage.—That when a patient had more than one wound or sore, it frequently happened that the disease was confined to one of the sores, while the other remained perfectly healthy, and this even when they were at no great distance from each other.

To these five arguments, three more may be gathered from Welbank's well-known essay, forming so much additional support in favour of the local origin of this disease. That part of the diseased surface may clear off and granulate, while gangrenous disorganization continues progressive at the opposite edge; that, however advanced the sore, it not unfrequently becomes healthy, and rapidly so, on the application of appropriate measures; and that the symptoms of general disturbance also which supervene are promptly relieved by measures that control the local condition.

Partly at variance with these facts and arguments, is the experience of Guthrie; that the febrile symptoms do seem to follow the appearance of the local alteration, is, in many cases, indisputable; that they precede or accompany the local symptoms in many other cases, is indisputable; and that the disease in a mild state, although capable of committing much mischief, is neither preceded nor followed by febrile or constitutional symptoms, cannot be doubted.

(2.) *Constitutional Origin.*—On the other hand, there are, or have been, those who affirm that the constitutional disorder generally, at

least, *precedes* the local disorganization. Thus, John Bell noticed that the hospital sore is usually preceded by a degree of fever. Thomson—writing also from his own observations—states that these two classes of symptoms—the local and constitutional—are not invariable in the order of their appearance; for sometimes the one, and sometimes the other class, seems to occur first in the order of succession; but that the constitutional symptoms usually precede the local. Hennen also advocated this doctrine even more strenuously.

The question of local or constitutional origin may be further examined by reference to the known causes of hospital gangrene.

External Causes.—All observations respecting the etiology of this disease agree in certain particulars; that it occurs as an *endemic*, springing up in some way among those who become affected. Thus, newly built hospitals are free, so also are generally those built on high ground; while the disease arises in crowded and ill-ventilated hospitals. But it is regarded by some observers as possibly an *epidemic* miasmatic disease; for it may appear very suddenly, both inside and outside an hospital at the same time, and disappear after a time, although the sanitary condition of the hospital and the treatment of the wounds remain unchanged. This mode of production, in hospital gangrene, is urged by Von Pitha and Fock; and as an occasional source, it is supported by Billroth, who suggests the possibility of atmospheric organisms acting like a ferment, and thus inducing decomposition on the surface of a wound—a germinal mode of origin.

Infection.—Thomson regards the disease as possibly infectious. "I have seen," says he, "hospital gangrene introduced into an hospital by a single individual, and, when proper precautions were not taken, spread extensively among the other patients, but chiefly among those who lay nearest in the ward to the person originally affected or among those who had had most frequent intercourse with him. I have also known patients attacked in succession with hospital gangrene who had used the same bedding, or who, without using the same bedding, had occupied in quick succession the same small apartment." *Fomites*, therefore, can convey the infectious matter, and retain it some time. So highly infectious is this disease, according to Boyer's observation, that it broke out in wounded patients, who, hoping to escape, had quitted the infected hospital, and retired to elevated situations where they breathed the most salubrious air.

The *infecting distance*, or range of the contaminated air from the focus of infection, is unknown; but the disease certainly attacks patients at some distance apart (Thomson). Nor is the period of latency, after infection, more exactly determined. I think, says this author, I have repeatedly seen the disease attack patients in less than three days after they had been exposed to its influence.

The production of hospital gangrene by infection seems to be disproved by Blackadder's observations, and chiefly by the result of the following experiment. He placed three patients with clean wounds alternately between three other patients severely affected. Their beds were on the floor, and not more than two feet distant from each other; but all direct intercourse was forbidden, and they were made fully aware of the consequences of inattention to their instructions. The result was, that not one of the clean wounds assumed the morbid action peculiar to the disease, nor was the curative process in any degree impeded.

Contagion.—This mode of communication can be traced as the *only* cause, in all cases since the days of La Motte, 1722, and Pouteau, in whose posthumous works, published 1783, hospital gangrene was first specially noticed. Pouteau observed that it may be communicated to the most healthy wound or ulcer in a person of the best constitution, and breathing the purest air, by merely placing in contact with any such wound or ulcer, sponges, lint, etc., contaminated by contact with a sore undergoing the disease. Thomson concurs in the accuracy of this observation, as well as advocating the infectious character of hospital gangrene. Delpech traced its propagation in almost every instance to the direct application of the morbific matter to the sores. Blackadder also recognized this mode of propagation in ninety-nine cases out of every hundred. Welbank arrived at a precisely similar conclusion. He speaks of the disease as being highly contagious by using the same sponges to different patients. And Guthrie specifies this as one of the "conclusions" of his observations during the Peninsular War. Nay more, that it is contagious through the medium of the atmosphere applied to the wound or ulcer.

Boggie's experience during the same war compelled him to admit that hospital gangrene may be propagated by contagion, although he is disposed to attribute less importance thereto than to the continued operation of other local causes of an irritating character, in the shape of dirt, acrid applications, motion or mechanical irritation; attributing also considerable importance to other stimulating causes affecting the constitution, as hot weather, stimulating food, and the intemperate use of wine and spirituous liquors. In short, Boggie considers it inflammatory gangrene, and recommends antiphlogistic regimen.

While, however, admitting that all such conditions—local and constitutional—may *predispose* to hospital gangrene, it does not arise in numberless instances where they are conjoined in full operation. Their essential importance, therefore, cannot be allowed.

The etiology of hospital gangrene is so far obscure that its cause or causes, in the *first* instance of its occurrence, require further elucidation.

The general conclusion is this:—The disease may arise from overcrowding in an ill-ventilated hospital or other institution; also, possibly, from epidemic influence; and that the disease is perhaps communicated by infection, from the sore itself emitting a poisonous exhalation; but it is assuredly also propagated by contagion.

Treatment.—Guided by the etiology of hospital gangrene, the nature of our *preventive* measures is at once suggested. Provision should always be made for space and ventilation, relative to the number of patients, in the arrangements of an hospital, or of the wards allotted to the reception of wounded cases, whether from accident or surgical operation. When the *first* case appears in any hospital or other institution, our immediate object is to decompose the poisonous slough and discharge, and, moreover, arrest the progress of gangrene. Strong caustics, such as will fulfil these intentions, should therefore be forthwith applied. Arsenic was originally recommended by Blackadder. The liquor arsenicalis, or diluted with an equal quantity of water, or with twice that quantity, was used, according to the emergency of the case. Strong nitric acid was first employed by Welbank. Either of these caustics, or even the actual cautery, should be applied until a new, hard, dry slough is formed, encrusting a clean and healthy

surface. Bromine, or with the bromide of potassium in solution, was introduced by Dr. M. Goldsmith, U.S.V., and is much advocated by Dr. Hamilton. This agent has proved highly efficacious as a caustic, when thoroughly applied to the gangrenous surface, previously denuded of slough, or as a disinfectant and prophylactic dressing to unhealthy wounds. Pure bromine seems to have answered far better than a compound solution with the bromide; and a strong solution, ʒi. to ℥iv. of water, may be used with advantage to paint the integument, to the extent of an inch, around the gangrenous part, after cauterization; while a solution of half the strength, ʒi. to ℥viii., will be sufficient when applied as a dressing. To prevent the *propagation* of this gangrene, punctilious cleanliness as regards the hands of the dresser, lint, water, and other appliances, should be daily observed in dressing all other wounds, even the most trivial and healthy. The bedding, also, should be changed, and clean linen furnished, as often as may be necessary to prevent their impregnation and the accumulation of fomites. Free ventilation and isolation of the patient will have similar preventive efficacy, and should not be neglected, although the disease may not be assuredly infectious. When apparently of epidemic origin, it will be necessary to remove the patients, as in a military hospital, to another locality.

Constitutional treatment must have reference to the combined state of irritation and debility; by the administration of opium, quinine, and stimulants, with nutritious diet.

The protective value of these measures has long since been fully established by their results. Thus, in military hospitals, the disease is apt to occur. Yet my own experience in respect of hospital gangrene, as it appeared during the war (1855), in the hospitals in the Crimea and at Scutari, does not approach what was formerly daily observed in *civil* hospitals. In the Hôtel Dieu, for example, it raged without intermission for two hundred years; so much so, that "a young surgeon," says an ancient French author, "who is bred in the Hôtel Dieu, may learn the various forms of incision, operations too, and the manner of dressing wounds; but the way of curing them he cannot learn. Every patient he takes in hand must die of gangrene." Now-a-days, such scenes have passed away like a dream. This disease has not been witnessed for many years in the hospitals of this country, excepting on three occasions,—in the Middlesex Hospital, 1835, in University College Hospital, 1841, and in St. Bartholomew's Hospital, 1846-7. With these exceptions, true hospital gangrene—contagious gangrene—has not reappeared; and many experienced surgeons of the present day have no practical knowledge of it whatever. Billroth testifies to its equal rarity in many continental hospitals, as at the Berlin Charité, and that in Zurich it is unknown. The disappearance of a disease, once so frequent, once so formidable, can only be attributed to its causes having since subsided; and they are precisely the circumstances that have been specially obviated by the hygienic arrangements of the well-appointed and well-regulated hospitals of recent years; nevertheless, we are still bound to recognize hospital gangrene and to remember its etiology, as the best security for our continued observance of those protective measures which can alone prevent the recurrence of this disease in future.

CHAPTER XI.

POISONED WOUNDS.

Hydrophobia.

Hydrophobia is the constitutional disorder of the human species which arises from *contagion* with the saliva of a rabid animal.

The dog and cat, and other animals of the canine and feline species, are peculiarly prone to hydrophobia, or rabies, as the disorder is then termed; and there is abundant evidence to show that the bite of a "mad dog, cat, wolf," etc., induces this disease by virtue of the *saliva* thus introduced.

The *wound* itself is often trivial—a mere scratch or graze from a tooth of the animal in the act of snapping; yet a very large proportion of persons bitten by a rabid animal undergo hydrophobia, sooner or later, and die; and it is incredible to imagine that so many individuals, differing in their constitutional idiosyncrasies, should alike experience the same constitutional disorder, and that a fatal one, from a wound scarcely worthy of the name. The existence of a hydrophobic virus, in the shape of a peculiar morbid saliva, has been also demonstrated *experimentally*. Several animals were inoculated with the saliva of a rabid dog, recently dead; a dog, a cat, a horse, and a cock were thus infected by Dr. Zinc. Dupuy, in like manner, induced the disease by taking a sponge, which had been bitten by a mad dog, and rubbing it on the open sore of a sheep. Youatt drew a silk thread backwards and forwards through the mouth of a rabid animal, and having inserted it as a seton in the neck of a sound dog, this animal subsequently died of rabies.

If, then, the inoculation of a peculiar virus be indisputably the cause of hydrophobia, is this disease capable of being conveyed by clothes impregnated therewith? Can it be communicated by *fomites?* Clearly so; for a dog's tooth is itself a fomes. To this effect, also, Mr. Trevelyan, writing to Dr. Bardsley, states that, after losing one pack of hounds by rabies, he not only removed the straw, but had the benches of the kennel scalded with boiling water, and afterwards all the joints painted and filled up with hot tar; the walls were then whitewashed, and the pavement cleaned with hot water. Thus secure as he imagined, he collected another pack; yet rabies again broke out and recurred year after year. In consequence of these continual attacks, he removed the pavement, threw the earth beneath into the river, refitted, new painted, and whitewashed the kennels; ever after which the pack continued perfectly healthy.

The virus is usually introduced through a bite of the animal diseased, but the mere application thereof to ever so slight a wound, scratch, or other solution of continuity, in an *absorbing* surface, is sufficient. In such case, the lick of a rabid dog generally induces hydrophobia. The surety of inoculation will obviously be affected—by the number of wounds inflicted, by lodgment of the virus or its escape by hæmorrhage, and, above all, by unobstructed inoculation

through the naked flesh as compared with the protection offered by clothes. Thus, of fifteen persons bitten by a mad dog, and attended at Senlis by the Commissioners of the French Royal Society of Physic, ten were bitten on the naked flesh, and five through their clothes; of the former, five proved fatal. Apart from these modifying circumstances, there may be no evil consequence from the bite of a rabid animal, and the immunity enjoyed must be ascribed to some unknown peculiarity of constitution. Perhaps, observes Billroth, in not more than one out of twenty cases the disease ensues. But this proportion would appear to be far too low an estimate, as shown by the cases to which I have just referred; and also by the fact that, at Rochelle, of twenty-four persons bitten by a rabid wolf, eighteen perished.

Local Condition.—Hydrophobia ensues in a variable period, averaging about six weeks, from the date of the reception of the virus. The wound has generally healed, or it may not have healed quite soundly. In either case, slight pain of a rheumatic character shoots from the site of the bitten part to some distance; so that if the hand be the part first affected, the pain extends up the arm and shoulder, fixing itself in the trapezius muscle probably, or the proximate side of the neck. Sometimes a tingling heat, or even a sensation of cold, is experienced, rather than pain; but either sensation equally *extends*,—say, up the arm and shoulder. Generally, actual pain is felt, and eventually shooting towards the heart. Meanwhile the cicatrix swells, reopens, and discharges an ichorous matter. Occasionally no local symptoms occur; neither the customary radiating pain, nor any inflammatory condition of the cicatrix.

Constitutional Disorder.—After the lapse of some days perhaps, other and more formidable, because constitutional, disorder begins. The nervous system, together with its ally, the muscular, are the subject of all those phenomena which characterize this affection. The cerebro-spinal axis acquires undue susceptibility. Consequently, the symptoms are those of cerebral excitement, with excessive general sensibility, and spasmodic affection of the muscles engaged in deglutition and respiration, ending in convulsions of the whole body. Rapid-flowing thoughts, reviving memory, and fertile imagination, are expressed by a more animated manner and conversation; although, in some cases, a downcast pensive mien, yet withal irritable and peevish manner, prevails. Far more frequently, however, thoughts and fancies whirl through the brain tumultuously. An overwhelming dread takes possession of the poor victim, and his nights are sleepless or broken by starting dreams,—this state bordering on delirium; a dull heavy pain caps the head and oppresses the temples, light is intolerable, and the slightest noise jars the whole frame; pains occur in various parts of the body, and a feeling of constriction about the throat, with a difficulty in swallowing, especially liquids, and a distressing hickuppy catch in the breathing, sighing or sobbing. In the course of from four to six days, possibly only a day or two, the most remarkable symptom of true hydrophobia supervenes,— an *indescribable dread of fluids;* any attempt to drink—even the sight or sound of water. the thought of it, or anything associated therewith, as the noise of teacups, or of a pump—immediately excites a convulsive paroxysm, threatening suffocation. In some cases the slightest breath of air, a fly settling on the face, or a

bright light, has the same effect. From the commencement of the disease, the temperature rises, and even as high as 105° or 106° F.

The convulsive attacks are *paroxysmal*, with *complete* intermissions. A viscid mucus accumulating in the mouth occasions an *incessant action of the lower jaw* to extricate it. The pains now piercing the epigastric and præcordial regions, more particularly, the general sensibility becoming more and more acute, and the convulsive paroxysms more frequent, desperate, and protracted, soon exhaust the patient's bodily power, while his mind is hurried on to *furious mania;* and thus, when fighting for breath, or utterly worn out, the sufferer expires. The second or third day usually brings this happy release. It may be postponed to the fifth or sixth day. Age makes some difference, for children endure not longer than twenty-four hours generally.

Diagnosis.—I have italicized those symptoms which, contrasting with the phenomena of tetanus,, serve to distinguish hydrophobia. To these characteristics may be added two more—the *early* period of *death* from hydrophobia as compared with tetanus, and its *longer* period of *latency.* On this point, however, considerable extremes are recorded.

Period of Latency.—In 131 cases, none of the patients became ill before the eleventh day after the bite, and only three before the eighteenth day. In 222 cases, the disease showed itself eleven times before the tenth day; twenty-one, between the tenth and twentieth day; twenty, from three to six weeks; eighty-nine, from seven weeks to seven months; eighty-nine, from seven months to twenty-seven months; one, after four years; one, after five and a half years. In Hamilton's table, it occurred in seventeen cases, between eighteen and thirty days; in sixty-three, between thirty and sixty days; in thirteen, between three and six months; in seventeen, between six and twelve months; in four, from ten to twenty months.

In both these series the period of incubation extended to between the third and eighth week. The extreme periods, as determined by Dr. J. Hunter, were thirty-one days and eighteen months. The most extensive and authentic observations accord about *forty days* as the *mean* period of latency in the human subject. Here, then, is a season during which *preventive* measures can be employed with the prospect of success.

Treatment.—Prompt removal of the hydrophobic virus by the cupping-glass, and free excision of the bitten part, constitute the most effectual *preventative.* In a part so situated that excision is impracticable, free cauterization may be resorted to, either by the actual cautery, or with strong nitric acid, potassa fusa, or nitrate of silver. It is impossible to say how late, in the period of incubation, these means would prove successful; for, if not employed in any given instance, some constitutional peculiarity might itself avert the supervention of hydrophobia. There is just this poor chance of safety. But, considering the very large proportion of cases in which the disease does inevitably arise, no time should be lost. Excision, therefore, should be practised at the *earliest* opportunity, and not postponed, however long it may have been neglected; provided, of course, that in either case there be sufficient reason for believing or suspecting that the bite was inflicted by a rabid animal.

Before, then, resorting to a measure which entails permanent mutilation, more or less, the state of the *animal's* health in question should

at once, if possible, be inquired into. The dog and cat chiefly concern us in this country. Rarely is the rabid state any approach to the popular notion of a "mad" dog. No wild excitement appears, no savage tendency to bite, and certainly no dread of water, so remarkable in the human subject. Rather will suspicion be aroused on ascertaining that the animal evinces only some strange departure from its usual habits and manner. In very many instances this peculiarity is a disposition to pick up straw, bits of paper, rag, thread, or any small object in the way. The animal laps water greedily. A disposition to lick is noticed in some cases, and particularly to lick anything cold—cold stones, or the cold nose of another dog; great aversion, however, to strange dogs and cats, especially to the latter, is very commonly observed at an early period. Some such *unusual* propensity is soon followed by an *irritable*, peevish manner. The animal snaps at those about it, and resolutely fights if the least provoked, or vents its rage in peculiar howling or barking, the voice being husky and jerking. This state is known as *furious* rabies. When thus obviously dangerous, it is forthwith destroyed. Yet a dog dangerously rabid may be perfectly quiet and natural, save in respect of some unsuspicious, because unobtrusive, symptom. Allowed to run about, patted and played with as usual, it bites in an unguarded moment. In *this* state, therefore, although not manifestly rabid, the animal should be at once chained up. Instead of being killed, it can then be watched, to ascertain the real nature of its indisposition; thereby determining the necessity for excision in the case of any person who has been bitten. If the animal be affected with rabies, it will probably die in a few days; and this operation is imperatively demanded. The safe custody of the rabid animal will also effectually prevent further mischief being done during his short period of probation. Two other forms of rabies in the dog may be mentioned. But, in both conditions, the animal is not aggressive, and in one there is a manifest inability to bite. Thus, observes Fleming, in *dumb*-madness, the lower jaw is paralyzed and drops, leaving the mouth open, and showing the tongue flaccid or swollen, covered with a brownish matter, and a glutinous, stringy saliva lying between it and the lower lip, and coating the fauces, which sometimes appear inflamed. Slavering is almost peculiar to this form of rabies, but the animal is ordinarily helpless and not aggressive; it can neither bark nor bite, nor eat nor drink. In *tranquil* rabies, the dog lies rolled up, as if comatose, and indifferent to everything; it cannot be provoked to bite, and dies quietly in about fifteen days from the commencement of these symptoms of the disease.

Supposing an animal, not itself rabid, or bordering on that condition, to have been bitten—a healthy dog, bitten by another dog, decidedly rabid. The latter will, of course, be killed; but when may the former apparently healthy dog be allowed to go free?

The question turns on the period of latency among *animals*. In the dog it is considered to terminate about the end of the sixth week. At the Veterinary School, Alfort, when a dog is bitten, it is chained up for fifty days, and, if healthy at the end of that period, is restored to its master. Mr. Samuel Cooper used to mention in his lectures, at University College, an instance of a more extended period than that which regulates the preventive measure adopted at Alfort. A large Newfoundland dog, having been bitten by another dog, did not become

rabid until seventy days had elapsed; information the more valuable, since Mr. Cooper himself watched the case from beginning to end. In Lord Fitzwilliam's pack the disease appeared at various intervals, from six weeks to six months. We may therefore conclude, that an animal bitten by another in a rabid state should be chained up for a longer period than the experience at Alfort would suggest as an adequate preventive injunction—imprisonment for six weeks.

Preliminary to this question is another—the *communicability* of hydrophobia or rabies among animals and man,—a consideration essentially relating both to its propagation and prevention. Many facts tend to show that the communicability of this disease depends on the inherent capability of the animal affected to *engender* it spontaneously; failing which, he may bite in vain. The dog can generate rabies, and therefore can communicate it to another animal, or to man, in the shape of hydrophobia. Sheep, horses—the herbivora—and man cannot generate the disease, and therefore cannot communicate it. Thus, rabies in a flock of sheep, consequent on the bite of a rabid dog, is not communicated from one sheep to another, although the sound are often bitten by the diseased, and in parts stripped of wool (Dupuy). At the Alfort Veterinary School three sound sheep, two dogs, and a horse were inoculated with the saliva of a rabid horse; not one of them became affected. In keeping with this view, man cannot communicate hydrophobia. By the experiments of Vaughan and Babington, animals were inoculated with the saliva of hydrophobic patients, but without any effect. In an exceptional experiment by Magendie and Breschet, one dog of two thus inoculated became affected; but this animal might have been previously diseased, especially as rabies was rife at the time. Paroisse inoculated three dogs with the saliva of a man in hydrophobia; the animals were kept and watched for nearly four months afterwards, during all which time they remained quite unaffected. Similar experiments were conducted by Gauthier, Giraud, Girard, and Bezard, with the same negative results. Lastly, there is no instance of one human being acquiring hydrophobia from another labouring under this disease, although in many instances attendants have been bitten by such persons.

In conclusion, the general inference to be drawn from these facts is this—that in estimating the danger to human life incurred by the liberty of rabid animals, those only which can generate rabies, *e.g.*, the dog, are dangerous; and the disease acquired by inoculation, from one animal to another, as by the bite of a dog to a cat, is transferred with its original intensity. The human species affected with hydrophobia is harmless, should there be any tendency to bite.

Such considerations, coupled with a due knowledge of the duration of latency in different animals, particularly the dog, suggest adequate precautionary restraint; while, in the event of hydrophobic virus having been communicated to man through the bite of a rabid animal, the prevention of the disease then impending is fulfilled by free excision of the part bitten, as soon as possible, aided, if necessary, by cupping.

Curative treatment will be utterly useless, although it may be possible to palliate symptoms and prolong life. This may perhaps be effected by the plan of treatment recommended by Marshall Hall and Todd. It consists in removing all causes of irritation, bodily and mental, as by placing the patient in a darkened room, excluding any

draught of cold air, all noise and conversation. Narcotics, such as opium and belladonna, have alike been tried in vain. But chloroform has often given relief. The application of an ice-bag along the whole length of the spine seems to have some influence in allaying the excitability of the cord; while stimulants and nourishment support the patient in the exhaustion consequent on the convulsive paroxysms.

Snake-Bites.—Of Poisoned Wounds, in the ordinary sense, the bites of venomous snakes, happily of rare occurrence in this country, possess much surgical interest; chiefly with the view of preventing their constitutional effects, rather than the more hopeless intention of curing them. The local effect of a poisoned wound is essentially *cellulitis;* inflammation of the subcutaneous cellular texture, announced by acute burning pain, accompanied with some, and perhaps, subsequently, enormous diffused swelling, not at first involving the skin. In severe cases the swelling spreads rapidly, and to an almost unlimited extent, so widely may it range.

The bite of the viper, occasionally found in England, and that of the rattlesnake, the cobra di capello, the whip-cord snake, the phoorsa-snake, the tobacco-pipe snake, and the puff-adder, of Eastern countries, answer to this general description.

Local Condition.—A piercing pain is immediately felt, rapidly shooting through the limb; swelling quickly succeeds, and a mottled livid redness, indicating that the skin is now involved. The cellular texture of the whole limb, and perhaps down the proximate side of the trunk, becomes gorged with a bloody sanious fluid; and, as if to relieve this tense yet diffused swelling, phlyctenæ arise here and there. Very shortly the pain abates, the tension is exchanged for a flaccid softness, the limb is cold and benumbed; while patches of gangrenous skin announce that the work of destruction has commenced, not however disclosing the ravages already wrought beneath the skin in the subcellular texture, and still less the extent to which it may eventually be sacrificed.

Constitutional Disorder.—Rapidly as all this mischief is accomplished, the constitutional disturbance begins almost concurrently with the first introduction of the poison. Soon after the poisonous bite has been inflicted, symptoms of muddling intoxication ensue. The victim mumbles incoherently, and staggering, as if dead-drunk, is overcome with helpless prostration and oppressed breathing. Other and even peculiar symptoms are witnessed. Profuse cold sweating, bilious vomiting, and perhaps evacuations of bile; while a yellow hue overcasts the skin. Excruciating pain about the navel is sometimes experienced. The pulse quivers irregularly, the nervous system succumbs to the potent poison, and the sufferer expires.

Now, in order to prevent this fatal issue, and, moreover, the formidable antecedent systems, remember that the poison begins to operate almost immediately, varying in this respect, however, with the dose. Still its period of latency is short.

Period of Latency.—In one case—carefully recorded by Sir E. Home—a man was bitten by a rattlesnake at half-past two p.m., and brought to St. George's Hospital, by three o'clock; during this brief period of only half an hour the constitutional disturbance had become overwhelming; and in the interval, when the man went of his own accord to a chemist's shop for relief, he was observed to stagger, and

appear drunk. Death ensued. In another instance, the bite of a rattlesnake began to manifest its effects within the first half-hour.

Treatment.—If we assume the period of latency to be *under half an hour, preventive* measures should be very promptly employed. The poison may be removed from the bitten part, or arrested before entering the general circulation, or neutralized. The application of a cupping-glass, or excision, is calculated to withdraw the poison; a ligature above the part affected, fulfils the second purpose; caustics, the actual cautery included, the third purpose. These resources very much correspond to the plan of treatment enjoined by Dr. S. Weir Mitchell, of Philadelphia. Of these appliances, that of cupping is most efficacious and practicable, if not the only one of value. Diffuse *inflammation*, consequent on the introduction of the poison, must be treated by free incisions and fomentations. *Curative* treatment has very little effect in overcoming the constitutional condition of utter prostration. Stimulants, such as brandy, wine, or ammonia, must be freely administered. Arsenic, in large doses, has been recommended as a specific. Such is the "Tanjore pill," a famous Indian remedy. But its efficacy is doubtful and even perilous. Dr. Halford's experiments led him to suggest the injection of ammonia into the veins, as tending to prevent coagulation of the blood, and to stimulate the nervous system. The strong liquor ammoniæ is to be diluted with water, one part to two or three, and twenty to thirty drops are injected into one of the large veins near the bite. Three successful cases, by this method of treatment, are narrated in the "Brit. Med. Jour.," 1869.

Insect-stings comprise the poisoned wounds or punctures inflicted by a variety of insects; bees, wasps, hornets, gnats, mosquitoes, the scorpion, tarantula.

The *local* symptoms of irritation and inflammation excited by the virus introduced, and any *constitutional* febrility or nervous depression induced, are seldom severe and soon subside. But the symptoms may assume a dangerous or even fatal character, in persons predisposed by a low state of health; the sting being followed, perhaps, by erysipelatous inflammation of the part, or death taking place by syncope. Some such cases have undoubtedly occurred; as happened (July, 1872), in the person of a middle-aged lady, at Twickenham,—the sting of a bee behind the ear, was soon followed by unconsciousness, and death ensued in about an hour. A similar case, with a fatal termination in ten minutes, is noticed in the American "Journal of Medical Science;" and a bee-sting on the back of the finger soon induced vomiting, sweating, trembling, and great difficulty of breathing (Beck's "Med. Jurisprudence"). A number of stings, as when bees swarm and settle on the head of a person, may certainly give rise to alarming symptoms; and the locality of the part stung is sometimes also a source of danger, as the eye or the mouth, tongue, or pharynx, from swallowing a bee in a piece of honey-comb, or a wasp in a peach. The bite of the scorpion is less noxious than commonly credited in poetry and popular tradition, although in the East its effects may be more formidable; the virulence also of the tarantula, in Italy, has been much exaggerated, while the "tarantismus," or nervous excitement produced, and which is said to be curatively affected by dancing to music, is merely a fiction of imposture and prejudice.

Treatment.—The local irritation of insect-stings may be subdued by

cold, or slightly stimulant lotions; as lead lotion, or a spirit-wash, or by a solution of acetate of ammonia—spirit of mindererus—which acts apparently by neutralizing the formic acid of the virus. Protection of the surface, by means of flour, chalk, or olive oil, will also allay the irritation. Usually, however, any inconvenience soon passes off. But a sting in the pharynx, attended with diffuse swelling, may impede respiration, or extending to the glottis, cause suffocation; hence, the necessity for prompt interference, by means of astringent gargles, ice-cold water, scarification, or the application of leeches to the throat.

Dissection-Wound.—Inoculation with *decomposing* animal matter—septic matter—is a kind of poisoned wound, the type of which is represented by a dissection-wound. The cuts and pricks received in dissecting are more or less familiar to the personal experience of every student of anatomy.

Symptoms.—The effects, local and constitutional, are always the same; differing only in degree, according to the virulence of the poison introduced, and the previous state of health; thus giving rise to the mild and the acute forms of the infection. In both, there is some local irritation or inflammation, advancing perhaps to pustular suppuration, with inflammation of the lymphatics; and attended with febrile disturbance, of typhoid character, resembling pyæmic infection.

But, in the *mild* form of the disease, the puncture becomes surrounded with a red areola, a pustule arises, and bursting, discharges an unhealthy pus, while tender rose-coloured lines—the inflamed lymphatics—spread branching up the limb, and the axillary glands become enlarged and perhaps suppurate. Low febrile disturbance, with loss of appetite, and diarrhœa, accompany these local symptoms, reducing the patient to a cachectic condition, but which pass off in a slow recovery. All the symptoms of the attack are, however, of short duration—the local inflammation arising one or two days after the puncture, and the blood-poison running off, apparently, from the system in the course of a week or two.

In the *acute* form of the disease, the constitutional symptoms seem almost to precede, and they certainly exceed, the local at the seat of puncture. In twelve or twenty-four hours after inoculation, by a slight prick, or scratch with the hooks, in dissecting, a severe rigor—the pyæmic shudder—occurs, with great nervous depression, a rapid pulse, and marked anxiety of countenance. This seizure is accompanied with the formation of a small, perhaps insignificant, vesicle or pustule, containing a thin, milky or puriform matter, having an inflamed areola; a sharp, stabbing pain, fixed in the shoulder, and shooting down the chest, announces the commencement of suppuration in the axillary glands, and some red lines connect this purulent depôt with the puncture-pustules. In a few days, diffuse inflammation of the arm and forearm presents a considerable, sloughy œdema of the limb; and diffuse suppuration may extend rapidly from the armpit into the sub-scapular and sub-pectoral regions, or down the side, involving the subcutaneous cellular texture in a sloughy mass, without much discolouration of the skin. The constitutional disorder becomes more typhoid, and low delirium or coma supervening, death ensues in two or three weeks. Or, abscesses continuing to form, the patient, in a hectic state, at length sinks from exhaustion. Recovery may, indeed, occur, leaving him the wreck of his former self.

The *post-mortem* appearances are analogous to those of pyæmia, but exhibited principally by diffuse cellular suppurations. Billroth regards the infection from dissection-wound as a form of pyæmia, arising from the absorption of septic animal matter, with lymphatitis, but without phlebitis.

Conditions of the dead body most infective.—Putridity must not be supposed to signify an infective state of the body; the less advanced in decomposition, the greater the risk, not unfrequently, from the inoculation of the animal matter, and a fresh subject is often the most dangerous. The bodies of persons who have died in certain diseases are specially infectious; notably in blood-diseases which were attended with diffuse inflammation, of which erysipelas is the type, and particularly puerperal peritonitis. Hence, the peril of dissection, or *post-mortem* examination, in such cases; the serous effusions in the cellular texture, or into the peritoneum, being highly infectious, the slightest prick or scratch suffices for inoculation, and the merest abrasion which might otherwise escape detection, the virulent fluid will find out. Dead matter resulting from mortification, as a small spiculum of necrosed bone soaked with pus, may prove equally noxious. But, as already observed, the constitutional state of the person, thus inoculated, determines the liability of systemic infection.

Treatment.—Local measures consist in the prompt removal or destruction of the animal matter introduced. The immediate application of a piece of string, tape, or other ligature around the finger, above the wound, may prevent the poison entering the circulation. Any bleeding should then be encouraged, thus to cleanse the wound; as by steeping the part in lukewarm water, or by exposing it to a stream of water. But the wound had better be well sucked, and then cauterized by a firm touch with nitrate of silver. A drop of nitric or sulphuric acid is also very efficacious. Subsequently, inflammation or suppuration should be met, as usual, by free incision and poultice, the hand being supported in a sling. Constitutional treatment comprises stimulants, tonics, anodynes, a nourishing diet, and fresh air. In the event of lymphatic abscesses, early incisions must be made, to prevent the burrowing of matter. After recovery, the finger may long remain swollen and stiffened; a state of chronic inflammation or its result, which must be managed accordingly.

MALIGNANT PUSTULE, OR CHARBON, is also communicated by *contagion*, the poisonous matter being caught directly from beasts, or their remains; for the disease is not propagated apparently by the human species, from one individual to another.

Local Condition.—Soon after any accidental inoculation with the morbid matter, a stinging sensation is felt, and a red point appears, hardly elevated above the skin. Then, at this point, the cuticle rises into a blackish vesicle, which speedily runs into a slough, surrounded by an œdematous swelling, having a violet tinge, and spreading rapidly in all directions. Occasionally, neither vesicle nor pustule arises, only swelling. With obvious swelling, however, a sensation of tension, rather than pain, is experienced. Should several pustules arise, the disease is proportionately more perilous, and especially if situated on the neck or face; for then the swelling may be so considerable as to threaten suffocation or congestion of the brain. Indeed, malignant pustule is not unlike carbuncle in appearance, but differs from it in

being always the result of contagion. And this etiological consideration will always determine the diagnosis.

Constitutional Disorder.—A variable period having elapsed, the constitutional symptoms supervene. Fever, attended with pain over the stomach, and vomiting, is soon succeeded by delirium and prostration, as the termination of septicæmia. In this advanced stage, death always ensues.

The nature of the morbid matter itself is unknown, but it is developed in beasts affected with "contagious carbuncle." The poison may be imparted by any accidental inoculation, in handling the animal when alive, or during the manufacture of hides, wool, etc. Malignant pustule is consequently most rife among butchers, tanners, shepherds, and wool-beaters. It may also be produced by eating the flesh of animals thus diseased. Instances in proof of this mode of production are cited by Wagner and Turchetti. Temperature and moisture have apparently some influence, for the disease is most prevalent in damp localities, and in wet autumnal weather. The morbid matter—whatever it be—retains its poisonous power for a long time. Billroth alludes to the possibly spontaneous origin of malignant pustule in man sometimes, as it certainly does arise in cattle and other animals; but this source of production is disputed.

Treatment.—Preventive measures are obviously suggested in accordance with the known etiology of this disease, although in the pursuit of certain avocations it may be difficult so to protect the hands and exposed parts of the body as to escape contagion. Even then, however, the progress of malignant pustule can generally be arrested at its commencement by excision or cauterization.

GLANDERS is another disease derived by contagion from certain *animals*—the horse, ass, or mule—similarly affected. In the human species, it never arises as a primary disease.

Inoculation of the human species is apt to occur by handling either animal when glandered; and the constitutional disorder thence arising may be briefly described as fever, resulting in the production of many inflammatory tumours in different parts of the body, which have a great tendency to suppurate and fall into gangrene. Towards the close of glanders, in eleven of fifteen cases (Rayer), puriform mucus, mixed with blood, oozed from the nostrils; in ten of these cases, the discharge came from one nostril only; and in all cases the quantity was inconsiderable, sometimes scarcely appreciable. The eyelids, also, are tumified, and secrete a thick viscid mucus. Muscular pains, and diarrhœa with prostration, or delirium and coma, lead to a fatal termination. This disease runs its course in a period varying from a few days to many months, as an acute or chronic affection. After death, septicæmia is declared by numerous abscesses, or collections of bloody serum or puriform matter, in the cellular texture and in the muscles.

The *period of latency* in man varies from two to eight days.

Treatment.—I am not aware of any means whereby the progress of glanders can be arrested when once inoculation has taken place, however early our intended preventive measures may be applied. If in this respect unlike the bite of a rabid animal, a snake-bite, or malignant pustule, glanders has at least one advantage—the disease can always be *avoided*.

As bearing on the question of prevention, the early and exact diagnosis of glanders in *animals* is important. It is communicated to man by an animal in a state of disease so obviously characteristic that the danger cannot be overlooked.

Two varieties of this disease, in the horse, ass, or mule, are recognized by Dr. R. Williams. In *gangrenous* glanders, the animal immediately loses its spirits, and staggers; the nasal and conjunctival mucous membranes are beset with a number of red points, which at the end of twenty-four to forty-eight hours, become livid; the nostrils now discharging a yellow matter, streaked with blood. This condition lasts two or three days; then the nasal membrane falls into gangrene, and large ulcers form where portions have sloughed. The discharge increases and exhales a fœtid gangrenous odour; œdema of the nostrils, scrotum, and legs soon supervenes: at length, the nostrils being glued together, respiration fails, and the animal dies. In *pustular* glanders, the same general debility and fever are observable as in gangrenous glanders. The specific inflammation of the nasal membrane is an eruption of pustules, said to resemble confluent small-pox, followed by a copious yellow viscid discharge from one or both nostrils. After two or three days, these pustules ulcerate, sometimes internally, so as to destroy the bones and cartilages of the nose. By absorption of the nasal morbid secretion, the sub-maxillary glands become swollen and tender, but only on the inflamed side of the head. Such enlargement is called the "kernels." Œdema of the nostrils, the sheath, and hind limbs succeeds, as in the gangrenous variety; and respiration failing, death ensues on the eighth or tenth day, at latest.

Glanders is often accompanied with "farcy," and farcy often ends in glanders.

Button farcy is characterized by inflammation of the cellular texture, forming tumours in different parts of the body; the head, neck, and extremities, particularly the hind legs. In four or five days they soften and ulcerate. It is an inflammation of the lymphatic glands and vessels, usually beginning in the hind extremities, attended with lameness, and forming an irregular swelling of the limb, which at length ulcerates and discharges a sanious fluid.

The *period of latency* in glanders affecting *animals* is generally short. Two asses—one about a year old, the other about a year and a half old—were inoculated by Turner. In the former the maxillary glands became tender on the second day, and the discharge from the nostrils was established on the following day. In the latter the maxillary glands enlarged on the third day, but the nasal discharge did not appear until the sixth day. In a horse inoculated with farcy matter, the disease did not appear until the end of three months, and then precisely at the points of puncture. Gerard states that he introduced the matter of the discharge every day, at different times, into the nostrils of certain horses by means of a brush, and that the disease appeared on the seventh day, but in two others not until the thirty-second day.

Fortunately, however, glanders is not an eminently *contagious* disease, either from one animal to another, or from this source to the human species; and its *communicability* from one human being to another is very doubtful. A case once apparently occurred in St. Bartholomew's Hospital; a healthy nurse contracted disease from a glandered patient, and she died after a short illness, having every symptom of glanders.

Assuming that glanders can be readily detected and distinguished from all other diseases, the prevention of its *first* propagation will consist in forthwith destroying the diseased animal, from which, as the centre of contagion, it might spread. But this precaution is not alone sufficient protection to man or beast. The disease is communicable by *fomites*, as well as by direct inoculation from one animal to another. In this way, some of the discharge from the nose of a glandered horse having remained about the manger, rack, or partition of a stable, may be thawed by the breath of a new horse, or introduced into the system in the act of nibbling or licking, whereby sound horses have speedily become glandered when put into a stable whence a glandered one had been taken weeks or months previously; thus reviving the disease, and with imminent peril to grooms and others in attendance. "Let, then," says Youatt, "the halters, head-gear, and bridles be burned; the clothes washed and baked; the pails newly painted; the racks and ranges thoroughly scraped, then washed well with soap and water, and afterwards with chloride of lime and water, in the proportion of a pint of the strong solution to a pail of water; let the walls be well scraped and washed with the chloride of lime and water, then well lime-washed; the floor be first thoroughly scoured, then sluiced with the chloride: and, with all these precautionary measures, every possibility of danger will be removed."

DISEASES OF THE NERVOUS SYSTEM.

CHAPTER XII.

SHOCK OF INJURY.—COLLAPSE.

SHOCK.—*Symptoms, and Diagnosis.*—Failure of the heart's action, or cardiac syncope, is the immediate effect of any sudden and violent impression on the nervous system. This failure of function is denoted by a thready, feeble, slow, and afterwards frequent and perhaps irregular, pulse; which is accompanied with pallidity, a cold clammy skin, with a reduction of temperature averaging one or two degrees, a haggard look, and lacklustre eye, great muscular prostration, soft sighing respiration, and, perhaps, some cerebral disturbance; symptoms which constitute the state known as Shock, or Collapse as arising from Injury. Other symptoms are exceptional and occasional only. Hickup, vomiting, relaxation of the sphincters, attended with involuntary micturition and defæcation; suppression of urine, convulsions, and stupor.

It appears, therefore, that in this state of functional suspension, both the nervous and blood-vascular systems are overwhelmed, involving, possibly, all other functions; but, as the shock of Injury, the nervous system is primarily affected, and *thence* the vascular system; thus differing from cardiac syncope consequent on hæmorrhage. A great physiological relationship underlies the pathology of Shock;—namely, that while the action of the heart is independent of the nervous system, it is much influenced and even arrested by any impression through that system. Not unfrequently, however, with Injury, *both* modes of origin—nervous suppression and loss of blood—co-operate.

Causes.—*Injuries* of all kinds—*e.g.*, incised and lacerated Wounds, Burns, Fractures, and Dislocations—are attended with Shock; and according to their *extent* as involving the nervous system, and their *persistence* as causes in operation. A burn, superficial in itself, but extensively involving a considerable cutaneous expansion of the nervous system, will cause more extreme shock than a far deeper burn of limited nervous consequence. Unreduced Fractures and Dislocations continue to operate, by laceration and pressure, on the nervous system. But injuries of organs, abundantly supplied with nerves, or in intimate relation with the nervous system, are equally influential. Thus, crushing of the testicle, or lesion of an internal organ, may prove fatal. The *part* injured has an important relation to shock. Head-injuries, affecting or involving the brain, are attended with more disturbance of the cerebral functions; while injury to the peripheral nervous

expansion suspends the reflex functions more particularly. Thus, a stunning blow or fall on the head may cause a more intense shock, apparently; but a crushed limb, with far less cerebral disturbance, may be a more fatal injury. Injury to the lungs, or to the heart especially, is attended with great shock; but, from injuries of the abdominal viscera, according to Professor Longmore's observations, the shock is more persistent.

Simple shock, without any apparent structural damage, may be equally deadly. A blow, for example, over the epigastrium; or pain, intense and prolonged; a stroke of lightning or exposure to cold. Certain poisons, probably, have an action resembling Shock; such are powerful sedatives, as tobacco, and powerful purgatives. Mental emotion may operate in like manner. Fear, or bad news, will cause the heart to sink in a moment, accompanied with the pallor of collapse; while a depressing passion, such as grief, weighs it down more permanently.

Predisposing conditions are, perhaps, very influential. Impressibility to the causes of Shock is, however, not an indication of its continuance; but generally inversely proportionate. Thus, shock may be easily occasioned, yet soon pass of, as in *youth;* or not so readily occasioned, and yet persistent, as in *old age*. *Premature age*, by intemperance or sexual excess, is peculiarly unfavourable. Sex is commonly supposed to have a predisposing relation to shock in the female constitution. But, under similar circumstances of health and the kind of injury in either sex, this unfavourable difference seems to be overrated, or is perhaps doubtful. *Prior disease* may unquestionably render the individual more susceptible to shock from injury; but it would appear, as Mr. Furneaux Jordan has observed, that it is in those persons who have suffered from the diseases of organs which are essential to life that such predisposition exists; as from affections of the brain, heart, lungs, or the kidneys more particularly, and, in a lesser degree, the liver and intestines; whereas, diseases of non-vital organs, or of the extremities, which merely depress the general sum of vitality, confer a lesser degree of susceptibility to shock. Thus may be explained the anomaly that shock is often more fatal in disease, and yet that amputation of the thigh for injury is more fatal than for disease. *Constitutional susceptibility* is well marked in the shock of some individuals; but it requires all the experience and judgment which the Surgeon can bring to his aid, to foresee this peculiarity. I remember removing a great toe-nail, under the local anæsthetic influence of ice and salt; the patient being a robust, ruddy-complexioned young woman. She sat up during the operation looking at her foot, and experienced no pain then, nor much afterwards. Yet no sooner had the circulation in the toe returned, then she became blanched and cold, and fainted—alarmingly several times.

Terminations.—(1.) *Death*, by *cardiac syncope.*—This may occur in two ways. Death may be sudden, from spasmodic contraction of the heart, not followed by relaxation; this mode of syncope occurring from some sudden and violent impression on the nervous system. Or, more frequently, the fatal termination is equally sudden, though perhaps gradual, as the effect of the cessation of the muscular contractility of the heart. I have seen a patient with severe compound fracture just removed to bed, restlessly attempt to raise himself once or twice, and

then drop dead on the pillow. The heart's action is paralyzed through the impression on the nervous system.

After death, in the one condition, the heart is empty, or nearly so; in the other, the heart is found engorged with blood, all its cavities being distended, especially the right auricle and ventricle. The venous system, generally, is similarly distended. Coagulation has taken place to some extent, but imperfectly; a considerable portion of the blood remaining fluid, while the clots are loose and dark. Sometimes the blood is altogether fluid. Rigor mortis commonly sets in, and sometimes very strongly. A significant fact is the accumulation in the stomach of any food which may have been taken, and that it has undergone little or no change; thus indicating the suspension of digestion, in common with other functions which can be observed during life. I have also frequently found the intestines comparatively empty, and singularly enlarged, owing apparently to atony of their muscular coats. Beyond these appearances, there is a remarkable absence of any discoverable lesion apart from the injury itself which has occasioned the shock.

Death by *asthenia*, from chronic shock, is an occasional result. *Necræmia*, or perhaps *thrombosis* and embolism, in consequence of shock, as affecting the blood, are also possible modes of death.

(2.) *Reaction.*—A natural restorative effort commonly ensues, in a period varying from a few minutes to thirty-six or forty-eight hours, or more. This reaction, as it is termed, of course implies the revival of those functions which have been temporarily suspended. The balance of the circulation is regained, the pulse acquiring force and fulness, and losing its frequency and irregularity. With it warmth returns, the actual temperature rising two degrees, or more—from 98 to 100 or 103 degrees; and the colour of the living body reappears. Respiration becomes more perceptible, prostration is less marked, the individual evincing some inclination to turn from the supine posture, and the cerebral obscurity clears off. Ordinarily, I think, reaction is not a continuous restorative effort; but slight retrogressions towards collapse occur, followed by reactions progressively more and more complete; and it is by these series of ebbings and flowings, that the balance of the circulation and other functions is at length regained.

If revival be incomplete, a mixed state of exhaustion, with reaction, prevails.

Traumatic Delirium—as this compound state is termed—may have either an inflammatory or a nervous character.

Inflammatory Traumatic Delirium.—*Prostration with excitement*—as this state was first named by Mr. Travers—is denoted by a rapid bounding pulse, but weak and liquid. The skin is hot and the face flushed, but there is still a haggard expression. The breathing is hurried and irregular, there is much restless tossing about, and perhaps spasmodic action of the muscles, with great debility, and the mind becomes excited and bewildered. The patient now doses off, then flickers up, as it were, suddenly, with an agitated and tremulous manner, only again to wander, and again arouse. At length frenzy, possibly, subsiding in coma and re-exhaustion, with a cold clammy sweat, ends in death; or ultimately, reaction prevailing, the pulse regains its force, loses its frequency, and the healthy status is slowly re-established.

Nervous Traumatic Delirium is similar to Delirium Tremens, when the latter disorder occurs in persons of habitual intemperance. The symptoms are those of exhaustion rather than of excitement. Thus, the pulse is weak, rapid, and compressible, the skin bathed with a clammy sweat, and the tongue trembling, and coated with a creamy fur, or has a dry, brown appearance, and the patient labours under a depressed, muttering delirium; all these symptoms contrasting with those which are associated with the happy, triumphant, boisterous excitement which characterizes delirium tremens in a young and vigorous or less saturated drinker, and which may happen after a sudden debauch. But, in both forms of the disease, the delirium is peculiar; some one affair or person haunts the patient's mind, and of this he is always talking to himself—it is a busy, sight-seeing delirium; yet the delusion passes off for a few moments, when the patient is spoken to, and he answers rationally, although with a trembling agitation, broken speech, and a perplexed anxiety of countenance. Sleeplessness, with tremors, in a person of intemperate habits, portends an attack of this nervous delirium after injury; and which may soon be fatal—death taking place in a few hours or days, from cerebral effusion and coma, or from rapid exhaustion.

Maniacal delirium, or other phases of mental aberration, are occasionally induced in persons of temperate habits, by an injury or surgical operation unattended with shock. Hysteria, or a nervous temperament peculiar to the individual, would seem to be the predisposing condition in such cases.

Remote constitutional consequences are said to ensue after the shock of injury; resulting perhaps in sudden death, some weeks or months after apparent recovery. Hodgkin and James have directed attention to these consequences; but it is very difficult to connect them as such with the original shock.

The *prognosis* of shock is always precarious and uncertain. It will depend very much on the causes, immediate and predisposing, already mentioned. And here individual predisposition is a highly important criterion; and especially the natural calmness and hopefulness, or the irritability and despondency, of a patient. Watchful nurses recognize these distinctions in *their* prognosis, as well as surgeons. The explanation is obvious, that mental dispositions are not only predisposing, but also *persistent*, and therefore maintaining causes of shock. Persistent conditions of bodily injury are likewise unfavourable. The *extent* of an injury indicates rather the immediate intensity of shock, than the probability of its continuance, under treatment. A certain *fall* and *rise* of *temperature* may be taken as a sure ground of unfavourable or of favourable prognosis; the less the decline, the more favourable, and a fall below 97 degrees is proportionately a more fatal omen; while a rise of temperature to 100 or 102 degrees, during reaction, not later than the second day, is a salutary indication, a stationary temperature below 100 degrees being equally unfavourable; but a higher elevation to 105 or 106 degrees is an almost surely fatal sign. Age affects the decline of temperature in shock; the fall being least in the young, lower in the adult, and lowest in the aged. After *surgical operations*, as a general rule, if *recovery* ensue, the temperature falls about half a degree; the maximum temperature of about 102 degrees is reached in from twenty-four to forty-eight hours, and then there is a descent, gradual and steady,

until the normal standard is regained, and which is maintained. In *fatal* cases, no fall of temperature takes place, as in cases of recovery. Chloroform seems to have little or no influence on the temperature. Although the thermometer thus supplies the most reliable indications of shock and reaction, the correspondence, observes Mr. Furneaux Jordan, between the temperature and the pulse, and especially between the pulse and the respiration, is less than in medical fevers.

Treatment.—This should have reference to the cause or causes of shock. Some are slight and transient, and reaction soon follows. Others, again, are more severe and perchance persistent; whereby the shock being more intense and lasting, reaction will be delayed and imperfect. The removal of any cause still in operation is, therefore, obviously of primary, and in a measure of preventive, consequence. Hence, surgical interference—as by the reduction of fracture or dislocation, of strangulated hernia, and the amputation of a severely injured limb—may be of vital importance, in the treatment of shock.

Remedial measures take effect according to the natural tendency to reaction, and this—even apart from the continued operation of causes—is not immediate. The patient should be placed in the recumbent position, and stimulants administered to further aid the returning circulation. Warm tea for children, brandy or ammonia and water for adults, may be given, provided the patient can swallow; otherwise, during insensibility, any fluid is liable to pass into the larynx and cause suffocation. Watching the effect on the pulse, stimulants must be repeated from time to time as occasion requires. Volatile ammonia may be held to the nostrils occasionally, when fluids cannot be swallowed. Then also, a stimulating enema, of turpentine for example, will be an advantageous mode of stimulation. In all cases, warm blankets, hot bottles to the feet and epigastrium, and perhaps galvanism, are available and effectual resources. The possibility of over-stimulation, by any of the means employed, must not be overlooked; remembering that sensation, for a time, is in abeyance, we should, as Professor Miller expressed it, "feel for the patient." In apparently *hopeless* cases, artificial respiration, patiently continued, may be resorted to with success. Opening the external jugular vein is recommended by Mr. Savory, in consideration of the engorgement of the right side of the heart and venous system. Collapse from the loss of blood by hæmorrhage from any cause, suggests the employment of "transfusion," as the special means of meeting this emergency. Nourishment also, to supply the loss of blood, is then a more immediately urgent requirement than in ordinary nervous shock.

Excessive reaction must be met by opiates rather than blood-letting; the fever being nervous more than inflammatory. The substitution of light nourishing food for mere stimulants, will be found advantageous; for there is still a strange mixture of exhaustion with *such* reaction.

Traumatic Delirium requires similar treatment. The quantity of opium borne with impunity, and eventually proving remedial, by inducing sleep, is often surprising. Grain doses of solid opium, or equivalent doses of the tincture, may be administered repeatedly, at intervals, according to the degree of excitement, with stimulants, in kind and quantities, according to the prostration or exhaustion, and the previous habits of the individual. The hypodermic injection of morphia is often a more certain and speedy method of administering a narcotic, without

any aggravation of the dyspeptic and hepatic symptoms which are commonly present. Chloral, in doses of from grs.xx. to ʒss., may be substituted for opium, but its action is less certain. Nourishing food should, as soon as possible, assist or supersede these more immediate resources. Not unfrequently any food is almost rejected by a sort of hickuppy vomiting, a symptom which is in itself distressing to the patient. Small pieces of ice swallowed occasionally may then afford relief; and hydrocyanic acid, or creosote, are sometimes even more useful. A brisk purgative, however, to remove any source of intestinal irritation, should be followed by small doses of blue pill, with rhubarb and hyoscyamus. The restraint of a strait-waistcoat may become necessary to prevent the patient interfering with the dressings or apparatus at the wounded part; but the increased tendency to cerebral effusion which is provoked by such resistance must not be overlooked. An ice-bag to the head will then be advisable.

The *question* as to the performance of a *Surgical operation during* Shock, is determined by two considerations:—the persistence, or not, of any cause in operation, as, for example, a bad compound fracture; and, secondly, the pathological fact, that the nervous system and circulation *already* in the state of Shock, is less susceptible of further shock than after reaction. An almost *immediate* surgical operation thus forms part of, and joins issue with, the injury for which it is performed. *After* that period of juncture, it is better to make a compromise with the vital powers, by waiting for *incomplete* reaction.

Chloroform is detrimental, in proportion as Shock prevails, and equally useless, owing to the comparative insensibility of the patient.

CHAPTER XIII.

TETANUS.

TETANUS (τείνω, to stretch) signifies a violent and involuntary contraction of the voluntary muscles, attended with severe pain and rigidity.

Symptoms, and Diagnosis.—The spasmodic contractions having commenced, never entirely relax throughout the course of the disease; they are *tonic*, thus distinguishing them from intermittent or *clonic* spasms in ordinary convulsions, as in hysteria or apoplexy; and complete consciousness is retained to the last, this additional peculiarity distinguishing the tetanic from clonic spasms in epileptic convulsions, and from those of hydrophobia.

Tetanus approaches and proceeds by the following series of spasmodic contractions, each continuing in the order of their succession. Stiffness is first experienced about the root of the tongue, which is usually retracted. Articulation therefore is imperfect. A sense of painful rigidity in the posterior muscles of the neck, and some difficulty in moving the jaw, are soon experienced. If the jaw be fixed, and tetanus proceeds no further, it is known by the name of *trismus*, or "lock-jaw." Generally speaking, other sets of muscles become involved. The facial muscles are affected; the angles of the mouth

being drawn up, a peculiar expression is presented, the "tetanic grin"—*risus sardonicus*. Deglutition is accomplished with great difficulty, and fluids are convulsively ejected when any attempt is made to swallow them. In this particular, tetanus resembles hydrophobia. Even the sight of fluids may occasion dread,—another point of resemblance. Yet in no other respect is there any similarity between these diseases. No foaming at the mouth of a thick mucus, with constant movement of the jaw to extricate it, is ever witnessed, as in hydrophobia. Other peculiarities supervene. Pain strikes through the body from the ensiform cartilage backwards to the spine, and being accompanied with intense spasm of the diaphragm, occasions agonizing dyspnœa, which has been compared to that of hydrophobia. Very soon the muscles of the back contract, and with such violence that the body is drawn into the form of an arch resting on the head and buttocks (opisthotonos); or the abdominal muscles contracting, become as hard as a table, and draw the body forward (emprosthotonos). During these spasms, the rectus muscle has been torn with the violence of its contractions. The body is sometimes bent to one side (pleurosthotonos); but I have never yet seen this distortion. Next in order, the muscles of the lower extremities are involved; and lastly, those of the upper, excepting the fingers, which generally remain movable to the last. The tongue also is rarely affected, although it may be thrust violently against the teeth and be much lacerated.

Such is the ordinary course of events in Tetanus. They constitute one continued manifestation of spinal excito-motion, without suspension of the cerebral functions; but, as would be expected, the tetanic spasms—violent and continuous—provoke general disturbance of the *organic* functions. Thus, the respiration being much embarrassed, the heart beats more quickly and forcibly, giving to the pulse similar characters; but they are eventually succeeded by feebleness and irregularity. The temperature often rises, and in a marked degree as death approaches; but there is no true inflammatory fever, from first to last. The urine is perhaps scanty and high-coloured, and is sometimes retained or voided in small quantities, while the skin pours forth abundantly a sour-smelling sweat. Lastly, obstinate constipation is a constant and significant symptom throughout this disease; and should an evacuation occur, it is singularly offensive. "I remember," says Abernethy, "on one occasion, asking an old nurse what sort of evacuations had come from a tetanic patient, who for a week had no relief from the bowels. 'Lord, sir,' she replied, 'they are not stools, they are sloughs.'"

The *diagnosis* of tetanus is not always clear. I have already noticed how it differs from hydrophobia, epilepsy, apoplexy, and hysteria. But it may resemble the latter disease. *Hysteria* with spasm—Hysterical tetanus—occurs sometimes in females, and presents a wonderful likeness. No fatal case is recorded. According to Dr. Copland, in females, trismus or subacute tetanus may assume an hysterical character, or hysterical symptoms may be associated with the tetanic, the disease being really tetanus and occasioned by any injury. Certain *drugs* produce spasms, resembling those of tetanus. *Strychnia* is thus specially deceptive. But the tetanic spasms induced by strychnia are remittent or intermittent, and subside entirely as the poisonous influence passes off, or kill in the first onset if the dose or doses be

sufficiently potent. All these points of distinction were observable in the case of Cook, and were successfully urged against Palmer in the celebrated trial for the murder of that man. *Morphia* sometimes produces convulsions, but they are epileptiform, and long in their development.

VARIETIES.—Sometimes trismus and general tetanic twitches supervene on continued prostration, and remaining associated with it, constitute a variety of "*prostration with excitement.*" The excitement is *tetanic.* Such were the phenomena I observed during the course of a severe burn, in the Royal Free Hospital. The burn extended over the toes and instep of the right foot and lower part of the leg. Its depth was to Dupuytren's fifth degree. The annular ligament was destroyed, the interior of the ankle joint exposed, as also were the carpal bones, and the nails were burnt away. An attempt was made to save this foot, which would, I believe, have proved successful, with the removal of portions of bone; but the patient, a middle-aged woman, was fat and flabby, and a hard drinker. Prostration continued, and in a few days partial trismus, with tetanic twitches of the arms and hands, set in. The patient's mind wandered; she frequently raised her head, uttered a few words, and then dropped on to the pillow, turning her eyes right and left with restless agitation. This condition having lasted for more than a week, the woman died exhausted.

In other cases of continued irritation *pure* tetanus supervenes. A man, says Travers, died of universal tetanus in a few hours after an oblique fracture of the thigh-bone, which penetrating the rectus muscle, was continually playing through its belly with a see-saw motion. A man having a simple fracture of the femur, and who appeared to be doing well for four days, was seized on a sudden with lock-jaw, and died in three days of acute universal tetanus. Examination showed that the upper fragment of the bone, obliquely fractured, had perforated and left a detached spiculum of considerable size transfixing the vastus internus muscle.

Certain varieties are noticed by Mr. A. Poland. *Spasms primarily attacking the muscles of the part injured*, instead of the muscles of the jaw. Two cases are mentioned, both of which were fatal. In the one, two months elapsed before the first symptoms occurred, a neuralgic affection of the muscles of the ball of the thumb, without any appearance of inflammation. The injury, originally, was a lacerated wound of the fleshy part of the thumb, by a splinter of teak-wood, which had transfixed the part. This was withdrawn at the time, and the wound healed soundly. But, after death, two pieces of splintered teak were found to be imbedded in the abductor muscle, and resting on a branch of the radial nerve. The other case was occasioned by a blow of a schoolmaster's cane on the hand. In this instance, both pain and spasm commenced in the injured part; followed by a gradual spasmodic contraction of the flexor muscles of the hand, drawing the fingers into the palm, and subsequently extending to the arm and other parts. *Absence of pain* was characteristic of one case, even to the last moment of existence. The cramps were accompanied by a tingling and agreeable sensation, with a strong tendency to laughter. *Special affection of the muscles of the face and eye* was noticed in three cases, simulating ptosis in two of them. The muscles of the eye are sometimes affected; the eyeball being fixed and drawn slightly in-

wards. The pupil may be contracted or dilated. *Cerebral complications* are very rare; but delirium may supervene towards the close of tetanus. *Epilepsy* is another quite exceptional complication, in a patient subject to this disease. Screaming and convulsions, apparently not epileptiform, may occur. *Motor-paralysis* occurred in two cases of the seventy-two, in Guy's Hospital, from which the above results were gathered. *Remission of the symptoms* is extremely rare, yet it has been noticed in several instances. In one case, according to Dupuytren, tetanus subsided for twenty-eight days, and then returned after an exposure to cold.

All these anomalous forms of tetanus are worthy of notice, as bearing on the, possibly obscure, diagnosis of this disease.

Pathology.—Until recently, the pathological anatomy and interpretation of the functional or pathological phenomena of tetanus, were involved in great obscurity. It has been regarded as essentially and primarily a blood-disease, the nervous system being secondarily affected. This view was revived by Rose, and it is that to which Billroth strongly inclines. But no evidence has hitherto been adduced in proof of any blood-disease. And although the essential nature of tetanus may yet require further elucidation, and especially by a more extensive assortment of *post-mortem* examinations, the original researches of Mr. Lockhart Clarke have brought to light a series of structural changes in the spinal cord, which are of the highest importance.

In six cases, these changes may be summarily stated as follow; and, apparently, in the following order of succession.

No morbid deposit nor any appreciable alteration of structure takes place in the walls of the blood-vessels of the cord; but the arteries are frequently dilated at short intervals, and surrounded, sometimes to a depth of double their diameter, by granular and other exudations; beyond and amongst which, the nerve-tissue, to a greater or less extent, has undergone certain changes. In the first stage, softening of this tissue; secondarily, granular disintegration, the tissue becoming softer or semifluid, and more transparent. Ultimately, the reduction of the tissue to a fluid state. This fluid, at first, is more or less granular, holding in suspension the fragments and particles of the disintegrated substances, but in many places it is perfectly pellucid. The blood-vessels also share in the disintegration of the part, and commingle with their ensheathing granular exudation. Thus a general softening and disintegration of structure has taken place. A fluid area, of considerable size, may occur at a single spot, and extend to the surrounding tissue; or at several spots, which advancing, coalesce between irregular

FIG. 82.

masses of the tissue, or portions separating, are left as islets in the fluid.

This process of destruction affects the grey substance of the cord; perhaps its central part. (Fig. 82.)

The same lesions of the cord are found in paralysis. But they are commonly unaccompanied by *spasm*, during life. Tetanus therefore probably differs only from that disease in being associated with a morbid condition or injury of some of the peripheral nerves. There is generally marked congestion or inflammation of some nerve connected with, and leading from, a wound that has occasioned the disease; the vascularity, which may be very intense, often extending up the neurilemma to a considerable distance. In the case of a man who died from tetanus, caused by a spike-wound of the thigh, corresponding with the anterior crural nerve to the extent of some inches, that portion of this nerve was distinctly inflamed; and my house-surgeon, Mr. Hamilton, had promptly extracted two pieces of clothing, which relieved the symptoms.

It would therefore appear—observes Mr. Lockhart Clarke—that this condition or injury of the peripheral nerves is the determining cause of the phenomena, and that the spasms of tetanus depend on the conjoint operation of two separate causes.

First, on an abnormally excitable state of the *grey nerve-tissue of the cord*, induced by the hyperæmic and morbid state of its blood-vessels, with the exudations and disintegrations resulting therefrom. This state of the cord may be either an extension of a similar state along the injured nerves from the periphery, or may result from reflex action on its blood-vessels excited by those nerves. Secondly, the spasms depend on the persistent irritation of the *peripheral nerves*, by which the exalted excitability of the cord was induced.

In so-called *idiopathic* tetanus, arising from exposure to cold and damp, it is probable that the morbid condition of the blood-vessels of the cord results from changes in the state of the peripheral nerves, which may act through reflex action or otherwise.

Associated with these essential changes of structural condition in tetanus, others, which are apparently incidental, may be noticed. According to Rokitansky's observations, in cases of some days' duration, a development of young connective tissue takes place in the spinal cord; as if tetanus had resulted from inflammation of the cord, —spinal myelitis. Or, a marked vascularity of the membranes of the cord and engorgement of the veins may be found within the vertebral canal. In a case of strangulated femoral hernia, for which I operated, all went on favourably for a week, and the incision had nearly healed; when suddenly the most violent tetanus set in, beginning with lock-jaw, proceeding to appalling opisthotonos, and terminating fatally on the fourth day, by which time the wound had re-opened and become gangrenous. I carefully examined the cerebro-spinal axis throughout its whole extent. The intra-spinal veins were gorged with blood, but not those of the cord itself. The intestines have been found much inflamed in several cases; and in two, a yellow, waxy fluid, of a peculiar offensive odour, covered their internal surface. The pharynx and œsophagus may be much contracted, and contain a viscid reddish mucus. The muscles are usually rigid, and sometimes ruptured; but sometimes there is no rigidity. The rise of temperature in tetanus has

been attributed to the muscular contractions, as the source of increased heat; but while the experimental observations of Leyden and A. Fick, with regard to dogs, might seem to bear this interpretation, tetanus, in the human species, may be unattended with any rise of temperature, even when the disease is most acute.

Causes.—*Injuries* of all kinds may possibly be followed by tetanus. From the most trifling scratch to the most terrible laceration, tetanus is liable to ensue, yet not with equal probability. But it arises most frequently from those injuries which, in point of their *extent* or *persistence*, by continued nervous irritation, are most conducive to the continuance of Shock. I have already noticed that variety of "prostration with excitement," in which the excitement is tetanic. Burns are thus peculiarly liable to induce tetanus. Punctured, lacerated, and contused wounds, particularly in the hand or thumb, of the sole of the foot or of the toes, have a direct tetanic tendency. Unyielding fibrous textures are peculiarly revengeful in this respect. Compound fractures and dislocations, rather than the simple form of these lesions, are threatening complications; and more so, if the fracture be oblique and playful among nerves and muscles, or if the dislocation be that of a ginglymoid joint, as the thumb. Gunshot wounds, involving possibly other forms of injury, rank high as causes. Amputation, as in the thigh, or the removal of a breast or testicle, are known causes. So also minor operations; *e.g.*, for fistula in ano, ligature of piles, extraction of a tooth, cupping, the irritation of a seton. *Diseases; e.g.*, gangrene, ulcer of the leg, a guinea worm under the integument, caries of the tibia. In obstetric practice; abortion, retained placenta. The influence of local causes in the production of tetanus, is shown sometimes by the order in which the muscles become contracted; the muscles adjoining the seat of injury being perhaps first affected, as happened in a case of gunshot wound of the thigh under my care; and Billroth has seen tetanus confined to one limb, or even to one hand.

The *condition* of a wound, at the time of tetanus, seems to have little relation to the disease. Thus, in one case, recorded by Hennen, cicatrization was completed on the same day that life terminated; and Dr. Elliotson observes, that the disease has sometimes declined and ceased, although the wound daily grew worse.

Period of *probation* or incubation, between the local injury and the commencement of tetanus.—This period has its *average* limits of duration. As extremes may be mentioned a few hours, or some days,—the fifth to the fifteenth day, and up to the twenty-second day; the average being the tenth day.

Tetanus arising from any of the foregoing forms of Injury, is denominated *traumatic*; as distinguished from tetanus arising from other causes, whether external or internal, unconnected with Injury, the disease being then named *idiopathic*. But this distinction relates to origin only, and is, moreover, not always definite. Such causes include exposure to cold and damp, hot weather, currents of air (hot or cold), bad ventilation or atmospheric poisons, irritation of worms, sudden suppression of the perspiration, of the catamenial or lochial discharges, or of acute diseases, and terror or anxiety of mind.

Predisposing causes.—The disproportion, in many cases, between the local injury and the development of tetanus, as well as the varying

period of probation intervening, are probably due to the influence of predisposition. A scratch of the thumb by a broken plate, proved fatal in a quarter of an hour; and in other cases, a slight blow, as by a whip-lash under the eye, although the skin was unbroken, has been followed by tetanus. In such cases, some predisposing condition probably was also in operation. *Age.*—No period of life is exempt; but, perhaps, infancy and middle age are most subject. In infants, the disease—then named *trismus nascentium*—appears from seven to fourteen days after birth. It may terminate fatally in ten or thirty hours, or life be prolonged to eight or nine days. Its origin is apparently traumatic; namely, from division of the umbilical cord, or irritation of the intestines by meconium, or worms; or it has been traced to unwholesome food, bad ventilation, or exposure to currents of air. It occurs very frequently in the Tropics, occasionally in Europe. *Sex.*—Males are most liable to tetanus, in a ratio of about seven to one female. *Habits of life* seem to have little influence, the disease attacking equally the temperate and the intemperate. *Constitutional susceptibility* is not apparent; individuals of any temperament being equally liable. *Climate.*—The disease is more prevalent in warm climates and in marshy districts; also near the sea-coast than inland. Nevertheless, *season of the year* is said to have no influence on the occurrence, or the mortality, of tetanus.

Course, and Terminations.—(1.) Generally, tetanus proceeds in a continuous course of development; affecting the muscular system, in the order already mentioned, and terminates *fatally*. About the second or third day, as *acute* tetanus; the ninth or tenth day, as *chronic* tetanus. But the former is commonly fatal, the latter far less so. The *mode* of death is, usually, during a *paroxysm* affecting chiefly the muscles of the larynx; which, by complete closure of the glottis, produce almost instant suffocation. The slightest attempt to move, or to swallow, seems to excite this issue. I witnessed it in one case, during the attempt to swallow an opiate pill. A sudden jerk of the throat took place, a suffusion of the face, succeeded by deadly pallor, and all was over. *Exhaustion* is another, but less frequent mode of death.

(2.) *Recovery* is preceded by a gradual subsidence of the tetanic contractions; and this happy issue is generally granted to the few who survive the tenth day. It is also stated, that the longer the period of *probation*, before the commencement of tetanus, the greater is the probability of recovery. Conversely, the shorter the period of probation, as well as the more rapid the progress of the disease, the more surely fatal is the issue. But this, perhaps, general rule is exceptional in many cases of rapid progress, after the probationary period of ten days.

Prognosis.—The prognosis of tetanus will be guided by a due consideration of the conditions which chiefly determine its tendency to a fatal issue, or to recovery. They are, principally, the traumatic or idiopathic origin of the disease, the influence of predisposition, as evinced by its speedy accession, and its acute or chronic progress.

Treatment.—*Preventive measures* are the most, or only, effectual resources. This implies the early detection and removal of any persistent causes in operation; such intervention necessarily having reference to local causes, rather than to constitutional conditions, which mostly elude detection or are beyond control. Hence prevention is practicable more frequently in tetanus of *traumatic* origin. Happily,

also, the intervening period of probation is available for surgical interference. Wounds may be thoroughly cleansed of foreign bodies, and the parts adjusted. Swelling, under tight, unyielding textures, may be relieved by incisions. Burnt surfaces may be effectually protected from the influence of the air. Most compound fractures and dislocations can be soon detected, reduced, and kept in position.

Are there any other causes possibly in operation besides the local injury? Constipation is constant and significant; significant, partly because constant, and also because of the peculiar matter voided when an evacuation does occur. No purgative medicines, however, that I know of, are specially serviceable.

The foregoing preventive considerations are most important; for every practical Surgeon will concur in acknowledging the hopelessness of all known medicinal treatment when the disease is fully developed; and, in such case, the equal inutility of any surgical operation to relieve the symptoms of, much more to cure, this deadly disease.

Remedies, then, there are none, at present known. The long list of medicinal and surgical resources which have been successfully tried, and have failed, Mr. Poland thus enumerates. Antiphlogistics, including blood-letting, purgatives, calomel, antimony, colchicum, etc., have been extensively used; alteratives, as the various preparations of mercury, large doses of fixed alkalies, solutions of arsenic, etc.; diuretics, in the form of tincture of cantharides, oil or spirits of turpentine, given in frequent and large doses, so as to irritate the urinary passages, or to occasion bloody urine; sedatives, such as digitalis, tobacco, nicotina, hydrocyanic acid, aconitina; anodynes and narcotics, as opium, morphia, belladonna, cannabis indica, ether and chloroform internally and by inhalation; stimulants and antispasmodics, including musk, ammoniacum, camphor, turpentine, assafœtida, castor, wine and other stimulants; tonics, such as quinine, bark, strychnia, iron, zinc, etc.; hygienics and dietetics, as support, milk-diet, etc.; injections into the veins of solutions of opium, stramonium, etc.; tracheotomy and laryngotomy. To which may be added, derivation from the spinal cord, by means of blistering, or the actual cautery, applied in the form of a hot iron or by moxæ along the spine.

This list of variously accredited remedies is at least suggestive of what to avoid, as useless, or perchance noxious, in the course of tetanus. Chloroform may relax the spasms, for a while, and thus relieve pain. It had this temporarily palliative influence in the overwhelming case, after strangulated femoral hernia, which I had reduced by operation. But death may occur under the influence of chloroform, by recurrence of the tetanic spasms, even to the production of opisthotonos; as happened in a case where I was about to remove a finger which had been mangled by the bite of a horse, and tetanus had ensued.

CHAPTER XIV.

DELIRIUM TREMENS.

No disease which falls within the experience of the Surgeon, as well as of the purely Medical Practitioner, can compare with that which I am about to notice, in the wide range of its significance, and its interwoven association with other diseases. Not even Scrofula or Syphilis are more prevalent, in some form of constitutional affection or taint, than is that insidiously broken and degenerate state of the constitution which may be traced to habitual intemperance in the consumption of alcoholic stimulants, whether spirits, wine, or beer. But this view of the subject opens up the wide extent, and the ramifications of the inquiry, into which we should have to enter, were I to attempt the full consideration of that "chronic alcoholism," to which, sometimes in the form of saturated sottishness, sometimes as "free living," or otherwise genteelly disguised, the people unhappily subject themselves. For here, alas! the victim, and the sacrificing priest, are incorporated in one and the same person—the "drinker," slain for the deity "Drink." The limits of a general work on Surgery will not allow me to do justice, if it were possible, to this theme; it must suffice to notice the incarnation of evil in its most pronounced form —"Delirium Tremens," or the Drunkard's disease.

Symptoms.—As the name of the disease aptly implies, the leading symptoms are delirium, coupled with trembling movements, to which should be added sleeplessness, and a general depression of the nervo-muscular power; exhaustion sometimes underlying this state of wakeful and tremulous delirium, so as to present a picture of "prostration with excitement." A person of intemperate habits has, for some days, looked dejected,—whether having the pallid, emaciated appearance commonly observed, or the florid and bloated face, with the fat and full-blown form, of other alcoholic *habitués;* he is restless by day, and sleepless at night; while a tremulous agitation of manner is exhibited in every movement,—particularly, perhaps, in a trepidation of speech, and a shaking unsteadiness of the hand, as in the act of writing, or buttoning the waistcoat; or even when the hand is not being used voluntarily, yet it shakes, nor can the individual hold it steady. Then, he begins to wander in conversation, or to talk to himself; and soon passes into that state of incoherence, that, coupled with other symptoms, no one can doubt an attack of delirium tremens has commenced. But the delirium is peculiar; it is essentially an active, or as it has been said, a "busy" state of consciousness; in which the patient is always doing something under the spell of his own imagination. What that activity may be, seems to depend very much upon the individual's own previous disposition and occupation. He may be busily engaged in some commercial transaction, or he would pursue some one against whom he has felt a grudge, or more often he is defending himself from some one who would injure him; but he never seems disposed to lay hands

on himself—there is no suicidal tendency. And, in all cases, this victim of self-excitement is occupied with some other person, or even a hideous animal, as the object of his intercourse, his aversion, or his fear. Then again, the delirium may be a boisterous excitement, usually in the younger aud more vigorous drinker; or muttering rambling, in the old, worn-out sot. But—unless in the last stage—the patient recognizes those about him, and can be made to understand, when spoken to. His attention being drawn away from his own imagination, the delirium passes off for a few moments. Thus, he puts out his tougue, when requested; and notice, this muscular organ also trembles; or, he thrusts out his hand, when you ask to feel his pulse. Then, however, he lapses again into his previous state of wandering, busy incoherence—not unconsciousness.

All the secretions point to the operation of a blood-poison. The tongue is commonly moist, and coated with a white creamy fur; it has also a flabby, sodden appearance, and may show teeth-marks along the edges. The breath is often fœtid. Perspiration bedews the skin, which generally feels cold aud clammy; but occasionally, a profuse, rauk-smelling sweat breaks out, uuder the influence of the patient's own exertions, or from his opposition to any necessary restraint. The pulse varies accordingly; usually frequent and feeble, loose or of low tension, it becomes sometimes more rapid, but of higher tension; yet in either case it is the pulse of prostration or of exhaustion. Other functions are perverted, although their derangements may be less constant. In a person who has lived more upon spirits, wine, or beer, rather than food, it is not surprising that the digestive orgaus should have got out of working order. Hence, the inappetency and nausea of the intemperate is often associated with a hickuppy rejection of food, and irregular action of the bowels—constipation, with scanty, hard, lumpy motions, alteruating with a fœtid diarrhœa. Probably the capricious action of the liver will account for these changes in the intestinal evacuations.

In the course of a few days, the incessant, restless delirium may be exchanged for sleep; the patient dosing and awaking to dose again; or he falls at once into a heavy slumber of some few hours' duration, from which he awakes quite a different man. No longer perhaps delirious, for the cerebral functions are so far restored, he still remains very weak; and not until digestion aud nutrition are reinstated, by the reception of nourishing food, is the recovery completed. Or, instead of the attack passing off, and the penalty of intemperance being thus paid, as it may have beeu upon more than one previous occasion, the oblation may now be offered by the life of the victim, who, becoming weaker and weaker, sinks rapidly from sheer exhaustion; or, still muttering to himself with lip-movements rather than any distinct articulation, he subsides into overwhelming coma, and dies. Is this the work of that cup of Lethe, so often drained to "drown trouble," for a while; or has "the glass which cheers but uot inebriates," proved an insidious foe?

After death, no lesions of the brain are discovered by anatomical examination, which can explaiu the clinical scene that has been witnessed during life. Generally, serous effusion is found to have taken place, on the surface of the brain,—under the arachnoid membrane, into the ventricles also, and throughout the substance of the organ:

presenting the well-known appearance of "wet-brain." Thus, the cerebral substance feels like wet putty in consistence, and slips about under the finger. There is perhaps no other more constant and peculiar organic condition, consequent on delirium tremens,—at least, when fatal—than this serous effusion on, and within, the brain. It may be accompanied with a congested state of the cerebral blood-vessels. But this additional pathological condition is found also after death from poisoning by opium, and as a constant result; yet which may be unattended with serosity of the brain. So far, there would appear to be a tolerably definite differential state of the brain in connection with delirium tremens. This pathological distinction, and thence the evidence derived from *post-mortem* examination, would be more reliable, were it possible to determine how far the cerebral congestion, as an occasional condition, may be due to treatment by alcoholic stimulation; the violent exertion of the patient, coupled perhaps with the effect of restraint, contributing also to the same result in delirium tremens. Probably, both the effusion and the congestion, when present, may have co-operated as the cause of death in this disease, from coma. On the other hand, examination after death demonstrates even more clearly the distinction between delirium tremens and inflammation, whether as affecting the membranes or the substance of the brain,—in the form of meningitis or encephalitis; the effusion in either such disease, having the character of lymph or purulent fluid, differs thus notably from simple serosity of the brain.

The *causes* of delirium tremens may be further considered with relation to its treatment. The intemperate imbibition of alcoholic stimulants, in some form or other, is undoubtedly the cause of this disease; and prolonged over-stimulation, or the habit of intemperance, is equally necessary to induce, or to predispose to, an attack. But the quantity of stimulant drank continually, varies much in different cases; a comparatively moderate quantity proving sufficient in some persons, who are naturally predisposed to the disease; a complete saturation being requisite in other persons. Yet, in either case, time, and thence habitual intemperance, is the essential factor in the production of delirium tremens. An attack of this disease is not the work of a day's debauch in a person previously temperate; but the product of continued alcoholism. Intoxication may, however, beget an attack of delirium in a person addicted to drinking; or, far less frequently, an attack arises, when such a person is suddenly deprived of his accustomed stimulation. This form of the disease, *delirium ebriosum*, differs; partly in the character of such an attack; principally, in the immediate cause, and the antecedent condition. But when a man of intemperate habits becomes sleepless and agitated, he is pretty surely on the verge of true delirium tremens. There are many persons who live constantly in this half-and-half state of the disease,—in chronic alcoholism. Something more is required to determine an attack. Various circumstances may then come into operation, as the immediate or *exciting* causes of the delirium. Increasing inappetency, and abstinence therefore from nourishing food; the drinker picking a bit now and then, or fancying only such things as hot tea and coffee, to whip up the stomach, or pickles, just to get something down. In this state of half-starvation, the disease is ever liable to set in. Or, the deprivation sometimes through penury,

coupled with the depressing influence of mental anxiety, may lead to an attack. Again, some bodily injury, slight perhaps in itself, may be sufficient provocation. It is in its *traumatic* production that delirium tremens most interests the surgeon; as with relation to wounds, fractures, operations, or other forms of injury, and their treatment. My experience inclines me to regard *traumatic* delirium, in some cases, as a form of delirium tremens, excited in a person predisposed by habitual intemperance. For I have observed that, in such persons, the delirium has no relation to the severity of the injury,—that even a slight lesion, as an incised wound, especially of the scalp, may have the effect of exciting the disease; and the almost immediate commencement of an attack after such injury, would seem referable to a predisposing condition, in the state of the nervous system, from chronic alcoholism.

The *course* and *terminations* of this disease are further considerations of special significance; the delirium passing off, and giving way to sleep, the patient recovers; or a fatal issue takes place, either by coma, or from exhaustion. Our *prognosis* will be guided accordingly.

Treatment.—Certain general indications with regard to treatment are obvious; namely, to induce the natural mode of recovery, and to avert the tendencies to death. *Sleep* must be procured, as soon as possible. If this indication can be fulfilled, by one sound sleep of a few hours' duration, the patient wakes up, rational, placid, and refreshed; in contrast with his previous state of delusion, and restless agitation or violence, yielding only to prostration. Of all narcotics, opium is the most efficacious. Experience cannot set any definite limit to the doses which may be administered, so great may be the tolerance of the system for the influence of this medicinal agent. But not to overstep that tolerance, in our endeavour to invite the return of Morpheus, the operation of opium in contracting the pupil, and reducing the frequency of the pulse, affords the best criterion of how far its narcotic effect can be borne with safety. The hypodermic method of administering morphia offers considerable advantages in delirium tremens; the narcotic action being more certain, speedy, and effectual; without any aggravation of the dyspeptic and hepatic symptoms, common in this disease. Thus, in the following case from the Report of the Royal Medical and Chirurgical Society, on this subject (1867), the comparative merits of subcutaneous injection are well illustrated: —A tailor's clerk, who, after giving up drinking for some time, had returned to his old habits, was suffering from severe delirium tremens. He had taken half-grain doses of the acetate of morphia at night, and twenty minims of liq. morph. hydrochloratis thrice daily, for two days, until the pupils were contracted, and yet he remained sleepless. The pupils were allowed to recover their natural state, and then only one-third of a grain was injected into the arm; the patient went to sleep in three-quarters of an hour, and no further opiate was required.

Chloral is sometimes given in conjunction with opium; or as a substitute, when that narcotic provokes sickness, or does not prove successful, or when the drug has lost its effect, in the case of an "opium-eater." Thus, then, there are cases where chloral may be resorted to. But, as a narcotic, it is not preferable to opium. On the contrary, chloral is not equally potent; its action is capricious, and not without danger to the life of the patient. It may be administered

safely, in doses of from ten to twenty grains, repeated every two or three hours, until sleep is induced, or perhaps even a hundred grains may have been thus given; watching the pulse from time to time. But further than that I do not think it judicious to try the influence of chloral. The dose has been carried to even fifty and sixty grains; and until the whole quantity taken has amounted to two hundred grains. Yet death has occurred suddenly in the course of such heroic treatment; a second fifty-grain dose having had a fatal issue, and in the case of a regular chloral-taker, whose system had gradually become accustomed to a single dose of that quantity. But it should ever be remembered that the action of chloral is cumulative; producing narcotism, when least expected, or suddenly overwhelming the patient. *Bromide of potassium* may be had recourse to with advantage, when chloral should be regarded with suspicion, and tried only experimentally; at least, such is my experience of the relative merits of these two agents, as narcotics, instead of opium, in the treatment of delirium tremens.

But another consideration of primary importance in all cases, is the improbability of procuring sleep, while the blood remains charged with the alcoholic poison. Here the disease presents a dilemma, which has given rise to much difference of opinion, as to the proper course of treatment. *Coma* threatens, from serous effusion on the brain, thus suggesting the continued use of the accustomed stimulants to maintain the circulation; on the other hand, the state of the blood, already charged with alcohol, forbids their further administration. It has been urged that a person long accustomed to alcoholic stimulants, cannot suddenly discontinue them with impunity. But this objection is over-ruled by the fact—first, I believe, adduced by Dr. Peddie—that in prisons, where a large number of confirmed drunkards are admitted and immediately placed on a diet without such stimulants, delirium tremens seldom occurs. Nevertheless, when the disease has commenced, the continuance of stimulants, in some measure, is mostly advisable, as a precaution against coma. Thus, I would recommend a compromise between the total deprivation of stimulants, during an attack of delirium tremens, which some have advocated, and that pouring in of brandy, wine, and beer, each or all of which may be regarded as only so much additional fuel to the fire. Greater restriction also may be practised in accordance with the pathology of the disease; the comparative absence of cerebral congestion, and that the tendency to coma arising from this cause, is much increased by any coercive restraint of the patient. When thus aroused to violent resistance, the turgid veins in the neck, the suffused face and blood-shot eyes, tell too plainly of the aggravated tendency to cerebral congestion and effusion. Hence, a strait-waistcoat should not be had recourse to unnecessarily, and then only as a temporary restraint.

Exhaustion can be overcome, for a time, by stimulants; permanently, only by such nourishing food as shall restore the blood, and thence the nervous system, to a healthy state. Here, perhaps, the chief difficulty in the treatment has to be encountered. Little or nothing in shape of food will settle on the irritable stomach. Blue pill, and effervescing ammoniacal salines, with, strange as it may seem, a moderate and regulated allowance of the patient's customary beverage, supply the best means of allaying the irritability of this organ. But the assimilation of food is probably very imperfect; and it is a far greater

difficulty to rectify the whole process of digestion, and also of textural assimilation in nutrition, than to pass the ingesta through the portal of the stomach. What diet may be most suitable, and at what intervals such food should be taken, must be left to the observation and judgment of the Practitioner.

CHAPTER XV.

HYSTERIA.

Few diseases admit of any exact and invariable definition; chiefly because disease is not an entity,—a something superadded to the bodily organism, in conjunction with the mind; but the whole body, and perhaps the mind, in a state of disease,—although manifested in one or more parts of the body, or even when the diseased state was itself of local origin. This indefinite character is especially true of the disease termed Hysteria. Its etymological signification, as if a uterine disorder, cannot be taken as the starting-point in the clinical history of this disease,—excluding the social and hygienic circumstances of its production; for Hysteria may be fully developed without any uterine disorder, from first to last; and a disease, essentially similar, may possibly occur in the male.

Perhaps, as an approximate definition, it may be said that Hysteria is a disorder of the nervous system, consisting principally of general exalted sensibility and excito-motory function, with an impairment of the controlling power of the will; this disorder being manifested by various nervous and muscular affections; or exhibited in functional derangements of various organs, simulating diseases of those parts, or occasionally masking and concealing their diseases; but in all of which, as forms of local hysteria, pain or other nervous symptoms are disproportionate to all the other symptoms.

(1.) *General Symptoms*, and *Diagnosis*.—In the pronounced form of Hysteria, an hysteric paroxysm, or an hysterical *fit*, sometimes termed an "attack of hysterics," presents a combination of symptoms, which is easily recognized, and is familiar to common experience. The symptoms are essentially nervous and muscular.

A young woman, of sensitive and nervous temperament, is not unfrequently seized with an alarming sense of choking, as if from a ball—the *globus hystericus*—rising from the abdomen into the throat; this is immediately followed by panting or deep sighing respiration, with violent action of the arms, beating of the breasts, or other movements, as if to relieve the agony of suffocation, aggravated by distressing palpitation of the heart. And the aspect of the person is peculiar. Her head is thrown back, the face appears somewhat flushed or suffused, but without lividity and distortion of the features; the eyelids are drooping and tremulous, half-concealing the eyes, which are bright or lustrous. She retains her consciousness, if not completely. The impulsive or uncontrollable movement of the arms, struggling as

if for breath, and the state of the countenance, continue for a few minutes, or sometimes a longer period; until suddenly, the fit terminates in bursts of screeching laughter, or in screaming, crying, or sobbing, perhaps alternating with laughter. As thus described, the hysteric fit differs from that of *epilepsy;* in which the person suddenly becomes unconscious, and falling down from loss of voluntary power, is seized with convulsive movements and contortions, affecting the body wholly or partially. This state is accompanied with strangling obstruction to the respiration, from laryngeal spasm; giving rise to turgid lividity of the face, and there is hideous distortion of the features. Protrusion of the tongue, which is often bitten and bleeding, grinding of the teeth, and foaming at the mouth, are further marks of distinction in the picture of epilepsy. Even in the partial form of this disease, the *petit mal*, complete loss of consciousness is the essential condition; the person losing himself, if only for a few moments, perhaps in the act of conversation; and recovering, without any convulsive movement, after this temporary fit of apparent abstraction, but real oblivion.

There is a modified form of the hysteric fit, wherein all the phenomena do not occur; the attack never coming to a crisis, or being "kept off," as the patient says, by a strong effort of the will. The fit thus *suppressed*, is always worse when it does come; and an attack of this kind may continue for days, the unhappy victim of hysteria seeming to be on the verge of an outburst. In such cases as I have seen, the nervous excitement is attended with a very weak state of the circulation, as denoted by a sense of chilliness and a pallid appearance, alternating with heats and flushing or mottling of the face, and an ever-ready flow of tears. The slightest emotion, or even the notice of a person when in this sensitive state, may be sufficient to swell "the fruitful river of the eye." This manifestation of hysteria nearly resembles hypochondriasis, which, when occurring in the male sex, has been regarded as another form of the disease.

Local Hysteric Affections, and *Diagnosis*.—In further pursuing the clinical history of Hysteria, the description of the general symptoms of this disease, as manifested by an hysterical "fit," conveys no idea of the various local manifestations which the disease often assumes in different parts of the body. No organ or part may be exempt, but the more common *seats* of these local symptoms are, without specifying the order of frequency in the parts affected: the joints, particularly the knee and hip; the female breast; the spine, from the atlas to the tip of the coccyx; the side of the trunk, especially under the left lower ribs; the abdomen; the bladder; the uterus, the ovaries, the clitoris and nymphæ; also, the nervous and muscular systems in divers situations. These organs and parts of the body, more especially, exhibit the symptoms of local Hysteria, whether by pain of a peculiar character, or some functional disturbances. Thus, a young female may be subject to pains in the joints and breasts; spinal tenderness, and acute pain in the coccyx on pressure; or abdominal tenderness with tympanitic distension, and pain in the left side; or there may be irritability of the urinary bladder, and painfully urgent, frequent micturition, with an abundant ejection of pale, watery urine; or some form of uterine disorder, as amenorrhœa or dysmenorrhœa, is not uncommon, associated perhaps with pain on slight palpation over the ovaries, and a general sensitiveness of the external genitals; or various nervo-muscular affections

are manifested, in the form of spasm, contraction, or sometimes of a paralytic character; and various exaltations or perversions of the special senses may perhaps be superadded to the list, the eye being intolerant of light, the ear of sound, or the smell perverts every odour to a stench, and the taste prefers wormwood to honey. Sometimes there are strong cravings for certain things, digestible or indigestible. Thus, I have known an hysterical lady suck lemons with avidity; and other patients have been disposed to eat chalk.

But the most remarkable and practically important feature in the local manifestations of Hysteria is this—that any such affection is apt to imitate and simulate or represent actual disease of the part, especially of an inflammatory character. Under these circumstances, therefore, in proceeding to the *diagnosis*, there is always the liability, not only of regarding structural disease as merely local hysteric, and thus of overlooking the requisite treatment; but the far more serious error may be committed—that of mistaking a local hysteric affection for structural disease, and of thence determining the treatment, as perhaps by having recourse to some surgical operation on the part which is apparently diseased.

Now, the characters of *hysteric pain* are these:—The pain is excessive, and disproportionate to any other symptom of the simulated disease; but the pain is also peculiar, in being cutaneous or superficial, rather than affecting any presumably diseased deeper structures, and it extends to perhaps far beyond the supposed seat of disease. This diffused and superficial or integumental pain is elicited on the slightest touch, and may then amount to agony; at times, however, it may be altogether absent, or suddenly it settles in some other part, and in either case of capricious cessation, the feigned disease vanishes. A deceptive appearance sometimes accompanies and remains after this local nervous affection; the part may be somewhat swollen, and thus slightly increased in size and altered in shape. But the disproportionate severity of the pain to the other symptoms of apparent disease in the part affected, will always attract attention; the comparative absence of other symptoms is no less remarkable; and, lastly, the absence of any constitutional disorder of local origin. Thus, in an hysteric affection of the knee-joint, as compared with inflammation, the severity of the pain, and its association with only a slight redness, or bluish discolouration, and slight puffy swelling, are sufficiently distinctive, and more so when taken in connection with the absence of inflammatory fever, passing on perhaps to hectic. Sometimes an hysteric affection becomes engrafted on a previous and independent disease of the part; but even then the hysteric character is always predominant. Should the diagnosis still be doubtful, any difficulty may often be cleared up by putting the patient under the influence of chloroform; for when pain and functional disturbance, as with relation to the knee-joint, are thus subdued, any structural disease of the part may be discovered more readily.

To impress upon the Student the peculiarities of hysteric pain, and, at least, remind the Practitioner of the kind of cases with regard to which he will often have to exercise a critical judgment, we may briefly notice the more common forms of local Hysteria, and which come under the notice of the Surgeon.

In relation to the *joints*, no better clinical illustration can be given

than the description of an hysteric *hip-joint* by Sir B. Brodie, who, I believe, first drew attention to this very important subject. There is pain, says he, in the hip and knee, which is aggravated by pressure and motion of the limb, and the patient often lies fixed in one position on the bed or sofa. You will say, are not these indications of a diseased hip-joint? But observe further. The pain is not, in general, fixed in any one part; it belongs to the whole limb. The patient winces, and sometimes screams, when you make pressure on the hip; but she does the same if you make pressure on the ilium, or on the side as high as the false ribs, or on the thigh, or even on the leg as low as the ankle; and everywhere the morbid sensibility is chiefly in the integuments. If you pinch the skin, lifting it at the same time off the subjacent parts, the patient complains more than when you forcibly squeeze the head of the thigh-bone into the socket of the acetabulum. As her attention is more directed to the examination, so the pain which she suffers from it is aggravated; but if her mind be occupied in conversation, she will scarcely complain of that which would have occasioned torture otherwise. There is no wasting of the glutæi muscles, and no flattened appearance of the nates; and the aspect of the patient is different from that which you would expect to find if the bones and cartilages of a joint were in a state of ulceration. Neither are there those peculiar and painful startings of the limb at night, attended often with frightful dreams, which mark the existence of this last disease. The pain will sometimes prevent the patient falling asleep; but, if once asleep, she sleeps soundly for many successive hours. And this state of things may continue for weeks or months, or even for years, without leading to abscess, or any further ill consequences. Sometimes there is general tumefaction of the thigh and nates; or, in a few rare instances, there is a more defined and circumscribed swelling; but without any perceptible fluctuation, and resembling a large wheal of urticaria. The limb may appear shortened, with elevation of the pelvis and bulging posteriorly, so as to form an acute, instead of a right angle, with the vertebral column; but this distortion is the result of disuse of the limb, and long-continued indulgence in an unnatural position.

With regard to the *breast*, an hysteric affection may be distinguished by similar symptoms. Integumental pain or tenderness, on gentle palpation, rather than deeper-seated pain on handling the organ. And this morbid cutaneous sensibility is not limited to the breast, but is diffused around, passing into the armpit and even down the arm. The examination is apt to excite reflex muscular movements and twitches, similar to those of chorea; and the patient either turns pale and faint, or her face becomes suffused with a rosy redness. But examine the mammary gland itself, however carefully, and no signs of inflammation can be detected; there is not even a blush of redness, and no swelling, beyond perhaps a general fulness, resulting probably from continued determination of blood, and which is increased by the slightest manipulation. Nor in the substance of the organ can any distinct tumour be discovered.

The *spine* is often the seat of hysteric pains, simulating the pain of "spinal disease." No local manifestation of Hysteria has been more frequently mistaken for structural disease than spinal hysteria; this affection being treated as caries, affecting the bodies of the vertebræ,

a disease of scrofulous character; or regarded as chronic meningitis or myelitis, the membranes of the spinal cord, or the cord itself, seeming to be the seat of inflammatory changes, consequent on some contusion or wrench of the spinal column. Numerous such cases of apparent spinal disease, as resulting from railway injury, are brought into a court of law for compensation damages. Yet the usual characters of hysteric pain are generally well pronounced; and although the symptoms do not supply *objective* evidence, they may be *tested* so as to become almost of equal value in determining the judgment of an observant and experienced Practitioner as to the nature of the case. The local symptoms taken in conjunction with the general symptoms of Hysteria, will mostly lead to a conclusive diagnosis. A spinal case is brought for examination, or the Surgeon is requested to visit the case, the patient being "unable to be moved." On passing the finger down the spine from top to bottom, including the coccyx, with an equal, tapping pressure on each of the spinous processes, an exclamation of pain is uttered, perhaps a shriek of agony, But the pain, thus severe, is not limited usually to one portion of the spine, and notably it is superficial, aggravated by light percussion on the skin, rather than by deeper pressure on the bone. Try the same mode of eliciting pain in the groove on either side of the processes, and the effect will be equally significant;—that pressure so as to reach the vertebral column, or the spinal cord, does *not* produce pain; whereas, gentle digitation of the integument *is* more or less acutely painful. Here, then, is both a positive and a negative fact, in evidence as to the nature of the case; the one fact indicating the presence of hysteric pain, the other fact the absence of any disease of the spine or of the cord,—at least, in most cases. Sometimes the pain is found to be entirely limited to the extent of one or two vertebræ,—*too* localized for any structural disease. And pressure on the tip of the coccyx is often specially painful. Lastly, this fictitious spinal pain is apt to shift its position; from the dorsal to the lumbar region, or up to the neck. In the course of caries, the angular deformity of the spine —the "hump-back," consequent on the falling down of the bodies of the vertebræ—leaves no doubt as to the distinction between this structural disease and a nervous affection.

Spinal hysteria having been thus suspected or discovered, our diagnosis may be aided by other concurring symptoms. There may be pains in the lower limbs, associated perhaps with weakness, or loss of power, amounting to paralysis; and this paraplegia may be accompanied with difficulty of voiding the urine. Spasmodic affections of the muscles are not uncommonly witnessed. Surely, here is evidence in favour of spinal disease. But, if the case be watched from time to time, these paralytic symptoms are found to vary very much in degree, and may vanish altogether; quite unlike the progressive and permanent character of paraplegia depending on disease of the spine, or of the cord. The constitutional condition of the patient remains unaffected, or is simply that of an hysteric person; and is thus unlike the hectic state which ensues from caries, or the cachectic condition consequent on paralysis. On viewing the patient also, our diagnosis may be concluded by the consideration that here, perhaps, is a young female, fat and plump; although, possibly, pale and sickly looking, from uterine disorder—not disease—in the form of deficient menstruation.

Hysteric pain in the *left side*, sometimes on the right side, is more often met with in pale, thin young women, who are subject to leucorrhœa. And it may be questionable whether the pain is not, at least in some cases, an affection sympathetic of vaginal or uterine inflammation.

Tympanitic distension of the *abdomen* is one of the most common forms of local Hysteria. The accumulation of flatus in the intestines gives rise to a general distension, which might be mistaken for dropsy of the peritoneal cavity, or for ovarian dropsy. But the absence of fluctuation, and the tympanitic sound on percussion, will plainly declare that we are dealing with a collection of air, and not of water; while the general character of the distension differs also from the more one-sided form of an ovarian tumour. And—as Sir B. Brodie remarks—a patient, when thus blown-up with wind, may actually float in a bath, instead of sinking as usual. This state of abdominal distension is connected with habitual constipation; the colon especially being in a torpid state, and more or less loaded with hardened lumps of fæces—*scybalæ*—which reside for some time within the cells of that portion of intestine. There probably undergoing decomposition, and being a source of irritation, gas is generated; and if, by breaking wind, some of it escapes, a reaccumulation soon takes place. Under these circumstances, a partial collection of wind, and its subsidence, may form one of those "floating-tumours," the nature of which is sometimes so doubtful.

Turning to the genito-urinary organs, we find them the busy scene of many hysteric affections.

Retention of urine often occurs; not from any structural obstruction to the free passage of urine through the urethra, but from some failure of the power to expel, or, at least, the disuse of voluntary power,—an illustration of *hysterical paralysis.* This may almost defy detection. But the absence of any other cause of paralytic retention, and the association perhaps of other hysteric symptoms, will guide the Surgeon's judgment aright on the question of diagnosis. When the bladder has been constantly over-distended in this manner, then retention may ensue from an enlarged and actually atonic state of the organ. *Incontinence* of urine, or an apparently involuntary micturition, is another form of Hysteria as affecting the bladder; the urine being shot out, at intervals, in a jerking stream. Retention and incontinence of this kind are far more commonly met with among female patients. But, in males, I have occasionally found stricture of the urethra of a spasmodic character, depending on Hysteria. Other symptoms have been present in such cases, and the passage of a bougie has provoked a distinct hysteric attack. These forms of the disease, whether vesical incontinence or urethral stricture, may be regarded as instances of hysterical *spasmodic* affections.

Hysterical *muscular* affections are often witnessed in the form of *contractions*, which may be associated with spasmodic movements of other muscles. And in persons predisposed, these functional derangements are often induced by very trivial causes; some mental emotion, as fright, grief, or surprise, such as, however, would not have unnerved a person of less nervous susceptibility; or some slight injury, unimportant in itself. Thus, Sir B. Brodie relates the case of a young lady, only twelve years old, whose forefinger of her left hand was pricked with the point of a pair of scissors. This little punctured

wound gave rise immediately to pain in the course of the median nerve; and the next day, the forearm was fixed by muscular contraction, at a right-angle with the arm. After a few days violent spasms affected the muscles of the hand and forearm, attended with constant vomiting. At length, the other limbs were thrown into spasmodic movements, so that the patient could neither walk nor stand. The diaphragm was sometimes affected, so as almost to threaten suffocation. Occasionally, lock-jaw took place, or the patient lay in a state of opisthotonos, as if *tetanus* were fully developed. A violent pain in the head set in from time to time, and this pain was described as having the same character as that of the pricked finger. These symptoms continued, in various alternations of predominance, until ultimately the patient recovered.

Wry-neck sometimes arises from hysteric contraction of the sterno-mastoid muscle. This state has misled surgeons of experience in not a few cases. But the diagnosis may be determined by the absence of any thickening of the fixed and rigid muscles, as would be produced by local disease or injury, nor is there the history of any sprain or crick of the neck; on the other hand, the concurrence of various symptoms of Hysteria may present a picture which those who have seen much of this protean disease will hardly fail to recognize.

Contractions of the *fingers* are occasionally met with, depending on hysteric affection of the flexor muscles; but looking like the prominent ridges in the palm, and the claw-like closure of the fingers, resulting from teno-synovitis, or from contraction of the processes of the palmar fasciæ. This state may continue for an indefinite period, and thus more nearly resemble the permanent contraction caused by disease. But the relaxing influence of chloroform will at once dispel the illusion; and even more readily than in other cases of functional muscular contraction, where the deformity is less conspicuous than in *club-hand*.

Various forms of *club-foot* may also depend on similar muscular affections of an hysteric character. A typical and suggestive case of this kind is related by the late Mr. Skey; and that the story shall not lose its effect in the telling, I will narrate the case in his own words, for what our American cousins would call "a caution." "A young lady, sixteen years of age, had been suffering, for eight months, from inversion of the left foot, which was so twisted as to bring the point of the foot to the opposite ankle,—in fact, at nearly a right-angle with the foot of the opposite side, an extreme case of *talipes-varus*. Her family consulted a surgeon of much experience in the treatment of distortions, and of orthopœdic notoriety. The case was considered as an example of an ordinary distortion, and the foot was placed in a very elaborately made foot-splint, by the force of which it was made to approach a parallel relation to the opposite foot; but it was an approach only, for no mechanism could retain it in a perfect position, the toes yet in some degree pointing inwards. Months elapsed and the disease continued unchanged. A second orthopœdic authority was then consulted in conjunction with the first, and as no new light was thrown on the disease by the combined opinions of the two, the same principle of treatment was recommended to be continued, and the mechanism was yet somewhat more elaborated. And thus the eight months of this young lady's life passed away, during which no constitutional treatment of any kind was resorted to, and loss of exercise,

with other attendant evils, had wrought a prejudicial influence on her health. When the apparatus which she had so long worn was removed on the occasion of her first visit to me, the foot immediately resumed its twisted form. The attitude of the limb was that of complete inversion. The disease had appeared almost suddenly in a person hitherto healthy up to fifteen years of age. It could not be due to congenital deformity, and the limb gave no indication of disease. There was neither heat, nor pain, nor swelling. In this case, also, there was no catamenial derangement. I removed the apparatus from the foot, bandaged the limb, ordered a full nutritious diet, with bark and iron, and having explained the nature of the disease to the friends, sent the young lady home to the country, recommending her to rely on the kindly offices of Nature—the greatest of all doctors, orthopœdists not excepted. At the end of a month, some progress had been made. She still walked with much difficulty, but it was obvious that she was improving in health and vigour of system. At the expiration of six weeks, she accompanied her family to a ball, her foot, as she entered the ball-room, being not yet restored to its normal position. She was invited to dance; and under this novel excitement she stood up, and, to the astonishment of her family, she danced the whole evening, having almost suddenly recovered the healthy muscular actions of the limb! She came to see me two days afterwards. She walked perfectly well into my room, and paced the room backwards and forwards with great delight. The actions of the limb were thoroughly restored, and all traces of the previous malady had disappeared."

In briefly tracing the clinical history of Hysteria, we have noticed several manifestations of functional derangement, whether by exalted sensibility or pain, and muscular affections of a spasmodic character, or in the form of contractions; to these may be added the apparent loss of voluntary motion—*paralysis*. Among the many paralytic affections, as they would appear, which may be referable to hysteria, retention of urine has already been alluded to, as being sometimes due to the failure or the disuse of voluntary power, in a person perhaps otherwise subject to symptoms of the parent disease. But hysterical paralysis is not unfrequently witnessed in the more pronounced form of *paraplegia* or *hemiplegia*. Arising from some mental emotion, as fright, the loss of voluntary power and sensibility in the lower limbs, or on the whole of one side of the body, more or less completely, may be referable to some slight injury, and not necessarily in any part of the spine, or the head. A sprain of the knee may as probably give rise to hysterical paralysis, as a contusion in the back. But the most remarkable element in the history of this paralysis is, generally, that the loss of voluntary power, and of sensibility, in the lower limbs comes on suddenly, and as suddenly ceases, although the apparent paralysis may have continued for months or even for years. Under the influence of some strong emotion, the pseudo-paralytic affection may vanish, perhaps in a moment; sometimes to return, sometimes leaving the patient permanently recovered. Dr. C. J. B. Williams mentions the case of a lady, who for several years having lost the use of her lower limbs, was startled by a rat running near her; she made an effort, and sprang upon a table; the power, however, did not remain, for she could not get down again. In like manner may be explained the supposed cures wrought by the excitement of religious

fanaticism; the "miracles" of Miss Fancourt, and Prince Hohenloe; and the more recent impostures of mesmerists, spiritualists, etc. But we live in an age which is essentially hysteric or *sensational*, whether in its social or religious aspects; and daily is the truth of Fenelon's philosophic judgment witnessed, that "the inherent weakness of the human mind is exhibited, not so much by its disbelief in the things which are, as by its belief in that which is not."

The *diagnosis* of hysterical paralysis will be gathered from the absence of any notable injury or disease, coupled with the history of the symptoms; and when they occur in past or present association with other symptoms of Hysteria, in perhaps the person of a young female who is thus affected, the Surgeon should duly weigh all this concurrent evidence. Some such cases are brought forward for medico-legal inquiry, in actions against railway companies, for compensatory damages on account of some alleged injury to the spine, or the head, from accident. There may be indisputable evidence of some injury, and that paralytic symptoms have followed. But the difficulty in estimating the nature of the case, whether it be hysterical or organic, is due to the character of the symptoms, as evidence. They are not objective,—there is nothing to be seen or touched; they are necessarily *subjective*,—that of which the patient herself, or himself, complains. The Surgeon is compelled to accept the statements of the patient on trust, for the most part; she declares she cannot move her legs, and she is never seen to do so, that she cannot feel when either limb is pinched, and she never winces under any test of their insensibility. Add to this apparently *bonâ-fide* evidence of paralysis, the fact that the patient's natural disposition, in Hysteria, is to deceive other persons, as well as herself, and that she lives for some weeks or months under the mental impression that her case is one of great importance, daily attracting the solicitude of her friends, and engaging the interest of her medical attendant; under these fostering circumstances, the paralytic affection continues. It is unnecessary to impute any dishonourable motives to the victim of Hysteria; nor would any honourable member of the Profession so identify himself with his patient's case, as to become, as it were, the plaintiff in the action. But he may enter so thoroughly into the case, that the symptoms and their connection with the accident are gone over again and again; the hysteric patient, always apt to learn, thus rehearses her part, until she becomes perfect in her *rôle*. In this state she is taken into court, pallid, emaciated, and paralyzed, looking the very picture of a wreck from "railway injury;" perhaps she has a "fit" in the course of her examination in the witness-box, though that species of concomitant evidence is always undesirable; the judge may direct the jury, but the jury think, or rather *feel*, for themselves; and thence a verdict is given, with substantial damages. I remember, in one such case, more particularly, where I had endeavoured to explain the true nature of the symptoms, with due regard to the plaintiff's suffering, as from the accident, no less than with fair consideration for the shareholders of a railway company, damages to the amount of £800 were awarded for the permanent injury the plaintiff had sustained. The following year, on one of the hottest days in July, I was sauntering up the hill at Richmond, my shoes sinking at each tread into the softened asphalte; a gentleman overtook me, and recognized me with a smile; having dropped the

character of plaintiff, so far from being a cripple for life, he was on his way to the park, to play in a cricket match! And I believe that not a few of these railway cases get well, after the trial is over. On the other hand, there are cases of irreparable injury, with paralysis more often than any other result.

The *causes* of Hysteria are mainly social and hygienic. As a disorder of the nervous system, its leading features are an undue general sensibility, with the loss or impairment of the controlling power of the will, and a corresponding exaltation of the involuntary excito-motory functions. With this disarrangement of the physiology of the nervous system, there is generally associated a feeble and susceptible circulation of the blood. Such persons chill and flush readily. Probably, therefore, the *nerve-centres* are subject to an irregular supply of blood; sometimes being in a state of hyperæmia, at other times anæmic. In conjunction with this twofold condition of the nervous and vascular systems, the digestion or primary assimilation of food is often imperfect, and it may be presumed that secondary assimilation or nutrition is also perverted. In some cases, there is a marked tendency to gout; in others, to scrofula. Now, this constitutional condition—representing what might be termed the hysteric *diathesis*—may either be congenital and hereditary, or acquired under the circumstances peculiar to the individual. Commonly, Hysteria is engendered by a vicious social training in youth, and by a similar existence in after years. No one was more entitled to write with authority respecting this social product than Sir B. Brodie, and he has recorded his convictions from an unusually large and varied experience. "You can render," said he, "no more essential service to the affluent classes of society than by availing yourself of every opportunity of explaining to those among them who are parents how much the ordinary system of education tends to engender the disposition to nervous affections among their female children. The boys are sent at an early age to school, where a large portion of their time is passed in taking exercise in the open air; while their sisters are confined to heated rooms, taking little exercise out of doors, and often none at all, except in a carriage. Then, for the most part, the latter spend much more time in actual study than the former. The mind is over-educated at the expense of the body, and, after all, with little advantage to the mind itself; for who can doubt that the principal object of this part of education should be, not so much to fill the mind with knowledge, as to *train* it to a right exercise of its intellectual and moral faculties; or that, other things being the same, this is more easily accomplished in those whose animal functions are preserved in an healthy state, than it is in others? This liability to Hysteria is, in fact, among females, one of the several penalties of high civilization. It is among those who enjoy what are supposed to be the advantages of affluence and an easy life that we are to look for cases of this description; not among those who, fulfilling the edict of the Deity, 'eat their bread in the sweat of their face.'" To this general description, however, must be added exceptional instances of Hysteria among the poor, and labouring classes. I have seen the disease fully developed in a country girl, sent up to the Royal Free Hospital, for the cure of an apparent chronic synovitis of the knee-joint, which was nothing but an hysteric affection. Thus, we may,

occasionally, refer the disease solely to constitutional predisposition, apart from the co-operative influence of social and hygienic causes. Sometimes the disease is elicited by an injury, perhaps of slight character; but, in such cases which have come under my notice, the constitutional tendency has been specially conducive. The relation of uterine disorder to Hysteria is twofold, occasionally being the cause, more often the effect, of the constitutional disorder. The independent dissections of Dr. Robert Lee and Dr. Snow Beck have clearly demonstrated that the uterus is abundantly supplied with nerves, by virtue of which this organ is brought into intimate connection with the entire nervous system. It may thus excite nervous disorder, or respond to the prevailing condition of the nervous system. But the nervous excitement of hysteria emanates from the uterus less frequently than may still be generally credited; for, in many cases, the function of menstruation is only secondarily impaired; while, in other cases, that function is fulfilled regularly and sufficiently, and seldom does the organ itself present any disease or displacement. Considering, however, the high nervous endowments of the uterus, it is not surprising that some uterine disorder, causative or consequent, should often be associated with Hysteria, which is essentially a disorder of the nervous system.

Treatment.—In considering the treatment of Hysteria, the judicious practitioner will begin by searching out these causes—physical, mental, or moral—which have produced the diathesis. Its evil origin lies often in the depths of a vicious education; an indoor life, with high-pressure schooling for accomplishments; while, in after years, the hysteric patient is often the victim of that *ennui* and mental fallowness, or moral perversion, which proceeds from the want of a daily occupation of the head and heart with something better than mere passing circumstances, the pursuit of some object in life, worthy of a rational and responsible being. No medicinal treatment can avail under any such adverse circumstances; but when they are corrected, then the resources of medicine and hygiene may do much to relieve, if not to cure, the symptoms of Hysteria. The nervous excitement is frequently accompanied with general muscular debility and irritability. Tonics and acute spasmodics may, therefore, be prescribed with advantage. And in these two classes of medicine, none are so efficacious as cinchona or cascarilla bark, and sulphuric ether or the etherial compounds. But one should not overlook the benefit to be derived, sometimes, from preparations of valerian, the nitrate of silver, or the sulphate of zinc; and the preparations of copper or iron,—having regard to the marked anæmia, which, in some cases at least, is associated with Hysteria. At the same time, turning our attention to the state of the digestive organs, the careful regulation of the diet is of paramount importance; for the appetite, although perhaps voracious, is rarely selective of digestible food; and the whole process of digestion is often imperfect, resulting in mal-assimilation, and constipation alternating with fitful diarrhœa, and lumpy fœcal evacuations from the cells of the colon or from an impacted rectum. Hence, a dinner-pill of gentian and aloes will prevent this oft-recurring source of intestinal irritation; while the administration of assafœtida occasionally, in pill or mixture, proves specially beneficial in routing out the offensive fœcal accumulations. Rectal constipation is perhaps best relieved by the simple *lavement* of

cold water, every morning, or an enema of soapsuds and castor oil, as occasion may require. There may be some uterine disorder, in the way of amenorrhœa or dysmenorrhœa, to which the Practitioner should direct his attention; but rarely, I believe, will it be necessary to have recourse to any local uterine treatment,—as for disease or displacement of the organ itself. The large collection of cases published by Dr. Robert Lee seems to have fully demonstrated the fallacy or the impropriety of the practice which was once advocated in the treatment of hysterical girls—the repeated and demoralizing introduction of a vaginal speculum, to inspect what?—"a prominent spot of varying size," "a something raised," "an abrasion or erosion."

As part of the general treatment of Hysteria, the management of a patient during a *fit* may be noticed. But little can be done to overcome the attack; much to prolong it by sympathetic interference. The dress, especially the stays, should be loosened, to allow free play to the breathing and relieve the oppressed action of the heart. Cold water may be dashed in the face and on the chest; while a few whiffs of ammonia, applied to the nostrils, may aid in bringing the person out of the attack. However violent and seemingly uncontrollable the struggles of the patient may be, no forcible restraint need be made; she is not likely to do any harm to herself, as in beating her breasts, and any attempt to hold her will probably aggravate the struggling. In some cases, where the hysteric attack is *epileptiform*, and the patient scarcely conscious, it may be desirable to see that she do not bruise herself in the more convulsive movements of such an attack. The tongue is less apt to be protruded and bitten than in true epilepsy; and, indeed, so far as I have witnessed an hysteric attack of this kind, the jaw is drawn down, and the tongue retracted within the widely opened mouth, as the patient fights for breath to overcome what seems to be laryngeal spasm, until the expectoration of a little frothy mucus suddenly brings relief. In any case, when an hysteric fit is over, sleep is the natural restorative from the exhaustion consequent on the muscular exertion.

The medicinal treatment of Hysteria must be reinforced by the hygienic resources of good air, and daily exercise out of doors, with change of scene and associations; thus to take the patient, as it were, out of herself. Bathing often proves very salutary; either in the form of the shower-bath, the hip-bath, or sea-bathing. Under this generally invigorating course of treatment, the hysteric diathesis may possibly be rectified; as an old physician used to say with regard to anæmia, he "washed the patient, ironed her, and put her out to dry."

Local hysteric affections are scarcely amenable to any topical measures, apart from the constitutional *régime*.

PART II.

SPECIAL PATHOLOGY AND SURGERY.

DIVISION I.

INJURIES AND DISEASES OF TEXTURES.

SKIN AND SUBJACENT TEXTURES.

CHAPTER XVI.

WOUNDS :—INCISED WOUND. WOUNDS OF ARTERIES AND VEINS.

A Wound is a solution or breach of continuity of the soft tissues, suddenly produced, in any part of the body, and by some direct external mechanical cause. Such lesion may be effected by various instruments of a cutting, tearing, or puncturing character. Hence, Wounds are commonly distinguished as Incised, Contused and Lacerated, and Punctured. Gunshot Wounds are also contused and lacerated. Poisoned Wound is characterized, not by the nature, and still less by the extent, of the lesion itself, which may be only a slight puncture; but, by the accompanying introduction of some poisonous matter, whereby the constitutional disturbance becomes of far greater consequence than the local lesion. Such are stings of bees, wasps, hornets; snake-bites; bites of rabid animals, giving rise to hydrophobia; and dissection-wounds.

Excluding, therefore, poisoned wounds; Wounds differ most significantly in their relation to the laws of Reparation. *Incised* wound has a natural *tendency* to undergo repair, or to heal, by primary adhesion, when its surfaces are placed in contact; all other wounds, in proportion as they are *contused* or *lacerated*, have a natural *tendency* to sloughing and then to undergo repair by the slower process, on an open surface, of suppurative granulation and cicatrization.

Incised Wound.

An Incised Wound is a solution of continuity of the soft textures; suddenly produced, and with even division of the tissues. The former character distinguishes this lesion from a breach resulting from ulceration; the latter character defines it from a contused wound.

Symptoms.—Pain, of a burning or smarting kind, and hæmorrhage or effnsion of blood, in various degrees, accompany the division of nerves and blood-vessels; and the wound opens or gapes more or less, according to the elasticity, muscular contractility, and weight of the parts. The former symptoms are not pecnliar to this, or any other kind of Injury; but absence of the latter condition, gaping of the wound, is the negative distinction of a *subcutaneous* incised wound. This lesion is, moreover, not exposed to the action of the air; a peculiarity of essential importance, as determining the course of a subcutaneous wound in respect to its more speedy reparation.

Cause and Effects of Incised Wound.—An incised wound is produced by the edge of any sharp cutting instrument, as a knife, chisel, or sword; not by a blunt or a pointed weapon.

Its effects are essentially local, in relation to the function of the part wounded; but the lesion produces constitutional disturbance in proportion to the implication of nerves and blood-vessels, and to the functional importance of the part in the system. Hence, the *Shock* of injury to the nervous system; the *Collapse* arising from profuse or persistent hæmorrhage; and the serious *functional disturbance* arising from wound of an internal organ, as the lung or intestine. The reduction of temperature is greater after shock, complicated by the collapse from hæmorrhage. Thus, Mr. Le Gros Clarke relates a case of cut throat, in a man aged sixty-three, where the thermometer fell to 91·2°, one hour after the injury, and rose, during reaction, only to 100·1°, in twenty-four hours. Some allowance must be made, in this case, for the mental shock, in addition to the shock of injury, as the hæmorrhage was not excessive. The patient recovered.

Traumatic or *Surgical fever* is simply that form of inflammatory fever which arises from a wound of any kind, or a surgical operation, if only the injury be of sufficient magnitude, as a compound fracture or an amputation, thus to induce this constitutional disturbance. Like ordinary inflammatory fever, the traumatic variety is essentially a blood-infection, proceeding from the absorption of materials at the seat of inflammation. This inflammatory fever, of traumatic origin, begins usually within a few hours after the injury or operation, and is then associated with the reaction from shock, or not until the second day or later; and it may subside in a few hours, or continue from two to seven days. In the course of wound-fever, the pulse and the temperature are generally concurrent; the one increasing in frequency as the other rises, and declining as it falls. The maximum temperature averages 104·9° (Billroth). But the degree of febrility does not depend on the magnitude of the injury or operation, nor on the part affected. Nor, again, does hæmorrhage, even to a considerable amount, seem to have any influence, beyond delaying the rise of temperature. On the first day, a high degree of temperature affords no indication that the fever will be of long duration. Its continuance is not influenced by primary union of the wound, nor, essentially, by the age and constitution of the patient. Lastly, suppuration does not determine the period of febrility. The febrile condition may return, from some cause of irritation in the wound, the inflammation of an adjoining part, or from the supervention of some secondary affection, as erysipelas, pyæmia, or tetanus.

Reparation.—Incised wound tends to undergo the reparative process

of healing by primary adhesion, *unaccompanied* by inflammation; when the surfaces of the wound are in contact. But an incised wound may heal by other modes of reparation, under different circumstances. It will therefore be necessary to here describe all these modes of healing, which are four in number; although the latter two will be found to pertain more especially to Contused and Lacerated, or open, Wounds.

Modes of Reparation.—Wounds may heal in one or other of four different ways, first clearly distinguished by Macartney; and subject to certain modifications, the distinctions he drew are still accurate.

First. Immediate union, without any intervening substance, such as blood or lymph. (Union by the first intention, and through the medium of blood—Hunter.)

Secondly. Union by the medium of coagulable lymph, or a clot of blood—mediate by lymph or blood. (Union by adhesion, or adhesive inflammation—Hunter. Union by first intention, as now commonly understood. Primary adhesion—Paget.)

Thirdly. Reparation by suppurative granulations.

Fourthly. Healing under a scab.

(1.) *Immediate union* is effected only under certain circumstances. Incised wounds may thus unite when the cut surfaces are immediately replaced in close contact, so that no substance of any kind intervenes. The blood itself is pressed out of the wound, the divided blood-vessels and nerves are brought into perfect contact, and reunion ensues by the opposed surfaces simply growing together. This process of repair is very speedy. It will take place in two or three days; possibly in almost as few hours. No intermediate substance exists in a wound thus healed; consequently no cicatrix or mark remains. Nature undertakes and may accomplish the immediate union of any incised wound, irrespective of its extent, provided only the conditions mentioned are fulfilled. Thus, divided nerves may reunite, as manifested by the recovery of sensation or other functions peculiar to them. But such restoration is, generally, very slowly effected. In a case under my care at the Hospital, the tongue was severed by an incised wound, extending nearly through the substance of that organ, which hung by a mere shred on the left side; dividing the gustatory and hypoglossal nerves on both sides. The divided portion having been promptly replaced and secured, in even contact with the root, complete reunion took place; the tongue slowly recovering the power of motion and the sense of taste.

(2.) *Primary Adhesion.*—A period of reparative inactivity, perhaps of short duration, succeeds the injury; during which the divided textures are indisposed to unite, although placed in apposition. But this condition of apparent inactivity may partly be due to interception of the process of reparation; either by the presence of some foreign body between the cut surfaces, or from continued hæmorrhage. The process begins whenever the textures are *glazed* over, thus sealing the blood-vessels. This appearance of the wound denotes either the previous exudation of reparative lymph, or the coagulation of a thin layer of blood, just sufficient for adhesion. Reparation then commences.

Reparative Materials.—*Coagulable lymph* and, possibly, *blood* are the materials supplied; and their reparative power is exhibited by the organization which takes place in either of them, spontaneously. John Hunter, so far as I know, first advocated the possibility of blood under-

going this change; and it was with him the mode of "union by the first intention." Subsequently, the organizability of blood was disputed by Mr. Travers and other observers. Now, however, it is amply confirmed by the microscopic observations of Zwicky, Paget, and Dr. W. T. Gairdner, not to mention others. I allude to observations such as these:—the organization of blood effused in serous sacs, particularly in the arachnoid; of clots in veins being converted into fibrous cords, or having evinced less constructive power, degenerating into phleboliths; clots forming distinct tumours in the heart and arteries; and the clot above a ligature on an artery becoming part of the fibrous cord which constitutes the impervious portion of artery.

Sir James Paget thus estimates the function of blood in the repair of injuries:—1. It is neither necessary nor advantageous to any mode of healing. 2. A large clot, at all exposed to the air, irritates and is ejected. 3. In more favourable conditions, the effused blood becomes enclosed in the accumulating reparative material; and while this is organizing, the blood is absorbed. Lastly, it is probable that the blood may be organized and form part of the reparative material; but even in this case it probably retards the healing of the injury.

Organization.—The process of organization which coagulable lymph undergoes, is briefly as follows:—*Fibro-cellular* or *connective tissue* is formed, but in either of two different ways, or by both processes of development simultaneously; and the particular mode of lymph-development is determined chiefly by the circumstance of exposure or not to the air. Lymph effused for the repair of *open* wounds generally develops itself into fibro-cellular tissue, through nucleated *cells* (Fig. 83),

FIG. 83.*

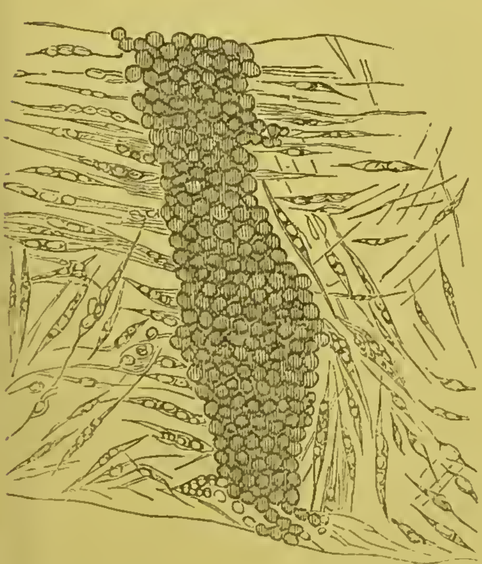


FIG. 84.†

which elongate into spindle-shape, or *fusiform* cells, and thence into filaments (Fig. 84); while that effused for the repair of *subcutaneous* wounds as generally develops itself into this tissue, through the

* Incised wound of the cornea in a rabbit; after *three* days. Union by emigrated cells, passing into fibre-cells in the adjoining connective tissue. 300 diam. (Billroth.)

† Cicatrix of incised wound in the lip of a rabbit; after *nine* days. Union by fibre-cells, fusiform, resulting in connective tissue. 300 diam. (Billroth.)

medium of nucleated blastema—by the *nuclei* developing themselves into fibres (Henle), or by the blastema itself passing through a fibrous transformation (Paget). The same state of organization—fibro-cellular tissue—is thus attained, by either of these different processes of self-development, or, as I have said, by the association of both in some, probably many, instances of reparation.

Fibro-cellular tissue thus produced, consists of cells lengthened and attenuated into fibres. This constitutes an intervening layer of textures as the permanent bond of union,—thence named connective tissue, and which presents externally the appearance of a linear cicatrix, or scar. Fibres of this kind must not be confounded with the very fine filaments seen in *coagulated lymph*, and which are produced apparently by the linear coalescence of molecules. The one are cell-fibres, and arranged when finished as fibro-cellular tissue, in fibres having cellular interspaces; the other are molecular fibres, and interwoven like felt in various directions, as seen in the clot of buffed and sizy blood, or in coagulated lymph exudation on the surface of a serous membrane. New capillary blood-vessels shoot through the connective tissue (Fig. 85); they are formed also in coagulated lymph, and occasionally in blood-clot, as reparative materials. These vessels are produced by a highly interesting process of development, as described with that of Healing by Suppurative Granulation, in Contused and Lacerated Wounds. Eventually, the new tissue is fashioned off, so as outwardly to resemble the particular texture in the substance of which it is interposed; but this resemblance scarcely extends to their minute structure. Reproduction of the original texture is, in fact, a rare event. Skin, with its papillæ and cuticle, muscle, tendon, artery, cartilage, and bone, in the first stage of fracture-union, are severally represented by fibro-cellular tissue, more or less vascular; nerve is said to be repaired in like manner, and also by the formation of new nerve fibres, which running through the connective tissue, become continuous with those in the nerve above and below, thus reinstating its continuity. The grey matter of nerve centres would not appear to be reproducible.

Fig. 85.*

Inflammation may, and often does, attend the process of primary adhesion; the healing is effected by what John Hunter named "adhesive inflammation." The divided capillary vessels, immediately adjoining the lips of the wound, soon become plugged with coagulated blood; whereby the collateral circulation is proportionately increased. *Cells*, identical with the pale corpuscles of the blood, or with lymph-cells,

* Cicatrix of incised wound in the tongue of a dog; after *ten* days. Development of looped and anastomosing vessels from adjoining sides of the wound, which vessels become atrophied and much diminished in the course of a few days. 70—80 diam. (Wywodzoff.)

are soon produced in abundance, within the interstices of the connective tissue immediately adjoining the wound. The production of these cells admits of at least a twofold explanation, as in the process of Inflammation. This cell-production may be due to the emigration of pale corpuscles through the walls of the capillary blood-vessels, according to Cohnheim's observations, supported by those of Stricker, Recklinghausen, and others; or, perhaps, the cells result from the proliferation of connective-tissue corpuscles in the textures undergoing inflammation, as Virchow maintains. Possibly, both modes of cell-production may co-operate. The inflammatory cellular infiltration is developed into connective tissue, in the way already described; and intercellular substance is deposited, which consolidates the newly formed tissue. This interstitial substance is most probably *fibrin;* produced, as Billroth believes, by transudation from the capillary vessels, under the influence of the wandering blood-cells. Schmidt's experiments point to the conclusion that a fibrogenous substance is deposited, which, by combining with the fibro-plastic substance of the blood and tissues, forms coagulated fibrin. But Thiersch maintains that this so-called intestitial fibrin is only the connective tissue itself, in a transformed state.

The external appearances which accompany, and as signs denote, this inflammatory state, are as follows :—In the course of twenty-four hours, the lips of an incised wound become red, and slightly swollen or puffed, painful or tender, and hotter than the adjoining integument; but this traumatic inflammation is restricted to the margins of the wound, in a healthy state; and reaching its height by the second or third day, the inflammatory reaction passes off by the fourth or fifth day, leaving the wound united at the end of a week. The cicatrix, however, appears as a red, stiffened line; but it slowly assumes a paler tint, and softer character; and eventually it changes into a white and somewhat depressed line in the skin; although this mark remains permanently, being visible to the eye, or detected with the aid of a glass, in after years.

Primary adhesion is less desirable than the immediate mode of union; the formation of lymph-cells being a process so indefinitely separated from that of pus-cells, that union thereby is much more likely to pass into suppuration than any process in which no lymph is formed; then again, it is probably not so speedy in most cases; and finally, if accomplished, it is not so close, a scar therefore always remaining by the organization of the new intervening substance.

(3.) *Suppurative granulation* and *cicatrization* is that process by which all other than incised wounds are commonly healed. It will be described in connection with Contused and Lacerated Wounds.

(4.) *Healing under a scab* ranks higher, in respect of its result, than that by suppurative granulation. Open wounds, and superficial burns, may heal in either way. The cicatrix formed under a scab more nearly resembles the natural textures, and being also less contractile, is less disfiguring. Yet the process of healing in this way is more liable to miscarry. Inflammation is apt to supervene, and discharge accumulating under the scab, the healing process is again and again delayed, or recommenced. No such impediment interrupts the progress of suppurative granulation, or the course of an *open* sore.

The scab itself is formed of dried blood, lymph, or pus; but the

precise nature of the reparative process underneath is concealed from our view. So far—observes Sir James Paget—as one can discern with the naked eye, the wounded surface forms only a thin layer of cuticle on itself; no granulations, no new fibro-cellular tissue, appear to be formed; the raw surface merely skins over, and it seems to do so uniformly, not by the progressive formation of cuticle from the circumference towards the centre, as is usual in open wounds.

Healing by the "modelling process"—originally described by Macartney—is somewhat similar. It takes place under a scab or protective film. But that "natural growth" of textures proper to the part, by which it was said to be re-made or re-modelled, and which was thought to be the special and characteristic feature of the modelling process, is probably only the growth of granulations, *without* suppuration, because not exposed to the air.

This mode of healing, like the last, is often witnessed in the wounds of animals. I have seen it occur in a gaping wound on the haunch of a horse.

The *Prognosis* of incised wound—as an adhering wound—is most favourable. But the breach of continuity may be maintained by various circumstances which prevent or impede coaptation of the parts. The *weight* and *mobility* of loose and pendulous parts tend to prevent union, or to disunite them in the process of healing by primary adhesion; disturbing conditions which are exemplified after removal of the breast. *Muscular action*, causing displacement, will have the same effect; and *tension* of the integuments is a similarly adverse condition, whether owing to any tightness of the part, or as resulting from inflammatory effusion. An amputation stump, after recent operation, is often thus circumstanced; at least, by the speedy supervention of swelling, and tension would be aggravated by scanty flaps. Any *foreign body*, *e.g.*, grit, or clot of blood, intervening between the surfaces, otherwise in opposition, will prevent complete union, and induce suppuration with an open wound. But the surfaces of an incised wound are usually clean.

Treatment.—To be effectual, in regard to this or any other lesion, surgical appliances must meet the requirements of the natural process of reparation, throughout its course; of which the treatment will then be a continued reflection.

The Indications are three:—(1) Arrest of hæmorrhage; (2) Removal of foreign bodies; (3) Coaptation of the opposed surfaces.

Hæmorrhage.—Small vessels soon spontaneously cease to bleed; their cut extremities retracting and contracting. Larger-sized arteries bleed *per saltum*, in jetting streams of florid red blood. Venous hæmorrhage is distinguished by the even flow of purple or black blood. The treatment of hæmorrhage will be described in connection with Wounds of Arteries and Veins. But the arrest of hæmorrhage, spontaneously, may be aided by exposure of the wound to cool air, or a stream of cold water squeezed from a sponge. Gentle pressure with the sponge on the cut surfaces will readily discover whether there be still any oozing from the bleeding points.

Obviously, any *foreign body*, if present, should be at once removed. Not roughly, however. The same application of water, as for hæmorrhage, will gradually suffice to dislodge and carry away grit, etc., or the particles may be lightly brushed off with a wet sponge.

Coaptation.—The coaptation of an incised wound might be postponed, until the wound has become glazed and adhesive. Then reparative material begins to exude. This indication as to *time* was always observed by Mr. Liston, with regard to the amputation-wound of a limb, and all other *large* wounds. The deeper and more extensive the wound, the more advisable is it to wait this event; with one exception,—a deep muscular wound, which retracting and gaping, non-interference would allow the muscles to become agglutinated within their sheathing fasciæ. But the *general* rule, applicable alike to small cuts, or to extensive and deep incisions, accidental or surgical, is this: hæmorrhage having ceased or been arrested, and any foreign body, accidentally present, having been removed, the wound is now prepared to undergo the process of reparation.

(1.) *Coaptation* signifies the adjustment of the opposed surfaces in even contact. This, however, implies a suitable position of the part, to relax any muscular action or tension.

(2.) *Retentive Appliances.—Dressing.*—The maintenance of coaptation during the process of adhesion, also implies the same attention to position, and some kind of retentive appliance; both being necessary to insure rest. In the selection of any such appliance, the plastic nature of the healing process would indicate that the less retentive it is, the better; provided only it be sufficient to maintain easy apposition. The Surgeon should always consider his mechanical dressings in this light; that he may the more exactly reduce them to co-operative conformity with the course of reparation. And by clearly understanding the proper management of a typical form of Injury, which occurs so frequently in Surgical Practice, as does an incised wound, and which represents nine-tenths of surgical operations, he will be enabled to take a commanding view of his art.

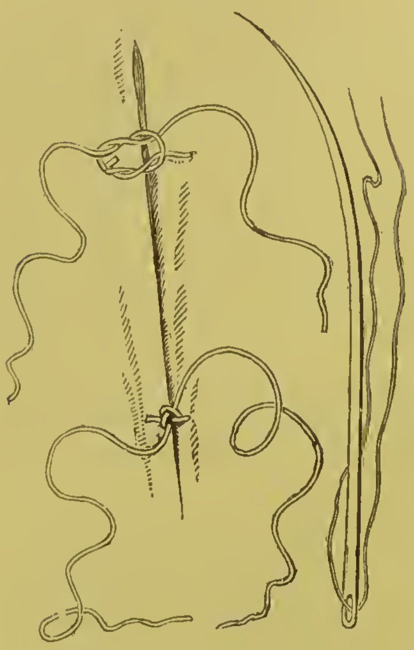
The appliances in question are designed to maintain the apposition of either the *lips*, or the *surfaces*, of the wound. Plaster, sutures, or both, fulfil the one intention; a bandage, with or without light compresses, accomplish the other purpose.

The *plaster*, commonly used, is the adhesive—diachylon—plaster. Isinglass plaster, introduced by Mr. Liston, is, however, preferable. It is equally adhesive, quite unirritating, and transparent, so that the progress of healing can be watched from day to day. If common adhesive plaster be used, the remark of Professor Gross is of some practical importance. It should be cut in the direction of its length, the texture in breadth being more yielding; so that if cut in that direction, the plaster is apt to become loosened when heated by the skin. Any blood or dirt around the wound having been washed off, the surface is lightly wiped dry with a clean soft cloth. If blood be allowed to remain, it stiffens, tightens, and irritates; nor can it be removed subsequently without an unwarrantable degree of handling and rubbing. Thus also, any hair on the part is better cut off in the first instance. Strips of plaster, of length and breadth suitable to the size of the wound, are then applied; and most advantageously, by placing the first strip over the *centre*, and another on either side alternately, leaving intervals between them wherever the edges of the wound lie in even and easy apposition. Any oozing is thus allowed to escape, the more so from a deep wound.

Sutures are made of silk twist; or metallic wire, of various kinds;

gold, silver, iron, or lead. They are apt to induce inflammation and ulceration of the skin around each, as a centre. Silver wire is, perhaps, less irritating than silk, which acts as a seton. A number of such sutures are, in effect, so many little setons, along the margin of a wound. Fine telegraph wire has been introduced into surgical practice by Mr. Clover. It consists of a fine copper thread, coated with gutta-percha. This is soft, flexible, tough, and perfectly unirritating; it admits, therefore, of ready introduction and knotting as a suture, and it may be left in the tissues for ten or fourteen days, without inducing any suppuration or inflammation along its track. Sutures, of some kind, are necessary alone, or as adjuncts to strips of plaster, whenever the wounded part is liable to be disturbed; whether by muscular action, its own weight, tension, or looseness. Such parts are the lips, tongue, soft palate, cheeks, nose, eyelids, ears; breasts, abdominal walls, bowels, scrotum, and the integuments around joints. When used, sutures are applied *before* the retentive strips of plaster; and only to bring the margins of the wound together, here and there, forming the "interrupted" suture. (Fig. 86.) Commencing in the *centre* of the wound, in order to judge of the even adjustment of the rest of its extent, the first suture is inserted by means of a curved needle, armed with silk or wire. Then another is placed alternately on either side, and so on, from point to point; but only where necessary to secure apposition. If silk be used, each suture is tied with a reef-knot; if wire-suture be employed, a twist or two will secure it. In either case the ends are then snipped off short. A few sutures only, as may be requisite, should be inserted; for, besides their irritating character, coaptation can be efficiently maintained in the intervals between them by straps of plaster.

Fig. 86.



Other forms of suture are employed in special kinds of incised wounds.

The "twisted" suture is a waxed thread, twisted or coiled into a figure of eight shape around a fine needle, previously transfixed through the lips of a wound in apposition. It is most serviceable for wounds in the lips, as in the operation for hare-lip, and for wounds of the abdominal walls. The "quilled" suture consists of a number of interrupted sutures, secured, not across the lips of the wound, but on either side, to a quill, piece of bougie, or other small cylinder, placed parallel about half an inch from the margins of the wound. Textures below the surface are thus approximated and steadily held together; an advantage in respect to a deep wound, as well as in any movable part. Ruptured perinæum is thus secured. The "uninterrupted" suture, or Glover's stitch, is seldom used, excepting for wounds of the intestine, which are stitched close so as, if possible, to prevent the escape

of fæcal matter. The "button" suture of Bozeman, the "clamp," and the "serrefine," of M. Vidal, may be here mentioned.

A *bandage* or roller, and *compresses* or light pads of lint, may be required to maintain the *surfaces* of a wound in contact. This, more especially, if the parts are muscular and liable to retraction, or bulky and apt to fall asunder. Deep or excavated wounds, therefore, mostly need this *extra* restraint or support. But it should be applied evenly, and only with sufficient pressure to invite adhesion, by preventing displacement and any oozing hæmorrhage. Amputation-wounds well illustrate the circumstances alluded to. Muscular retraction and weight of the flaps, thence recurring displacement and oozing hæmorrhage, are overcome and obviated, by the additional retention of compresses and a bandage applied with even and moderate pressure.

The line of incision, visible between the strips of plaster, needs only the protection of a piece of wet lint, as "water-dressing," covered with oiled silk to retard evaporation; and which may be occasionally moistened without removing it or otherwise disturbing the healing process. *Collodion* is sometimes used for the purpose of temporarily sealing the lips of an incised wound. Applied with a camel's-hair brush, it should be used quickly, and in such quantity that one application of the brush may suffice; for collodion is very adhesive, dries almost immediately, and contracts.

Antiseptic Dressings.—Disinfection and Deodorization have, of late years, attracted much attention, more particularly in this country; and, especially in the treatment or dressing of Wounds, whether occasioned by accident or by surgical operation. These terms, disinfection and deodorization, are not at all necessarily synonymous. Disinfection represents the neutralization or destruction of the infectious property, whatever that may be, in the atmosphere, or in any liquid, or solid substance, as an article of clothing—whereby a disease, itself infectious, is communicated and propagated; Deodorization signifies only the neutralization of an odoriferous property, and possibly, simply by masking it by some more powerful and penetrating odour. Probably, disinfection is far more frequently attended with deodorization, than the latter implies the former. Thus, solutions of carbolic acid, chlorine, and chloride of zinc are Disinfectants; whereas the aroma wafted from burning spices, or the fragrant spices of the East, employed in times gone by, would sweeten rather than purify the sick chamber; like the camphor-bag in domestic use, or the time-honoured rue strewed about the dock of our criminal courts; all such agents more often delude the sense only—they are Deodorizers.

Disinfection in relation to the treatment of Wounds, accidental or surgical, may be termed Antiseptic; the object being to prevent the putrefaction of any blood or liquor sanguinis extravasated, or of pus formed subsequently, and it would seem to also control the formation of the latter fluid. Thence, primary union of the wound is favoured, and the liability to purulent infection of the blood—Pyæmia—or to the decomposition of animal matter—producing Septicæmia—is prevented.

The *principle* of antiseptic treatment is twofold :—

Firstly. By the exclusion of air, as the infecting agent, from the wound.

Secondly. By the interposition of some positively disinfecting or antiseptic dressing, in the form of a close covering to the wound.

Professor Lister, who has mainly originated antiseptic treatment, enlarges this aspect of the principle, thus:—"An antiseptic to exclude putrefaction, with a protective to exclude the antiseptic, will by their joint action keep the wound free from abnormal stimulus."

This principle may be *fulfilled* as follows:—

(1.) Exclusion of air from a wound may be effected by simple water-dressing, as already described; care being taken to apply the dressing so as to form a close covering, and which is enveloped in oiled silk. Or, the air may be withdrawn by an exhausting receiver, as has been tried in France.

(2.) Antiseptic dressings of various kinds have been employed; and as a process of treatment, comprising many details, apparently essential to its success as a specific method, this has been named by Professor Lister the "Antiseptic System of Treatment."

(*a.*) The "protective" should possess several properties; it should be a material impervious to carbolic acid, and unstimulating in its own substance; at the same time, it must be insoluble in discharges, and sufficiently supple to apply itself readily to the part. Various materials have been tried and discarded; as a metallic plate, itself impervious, but when made of block tin, it was too rigid, and tin-foil soon wears into holes. Gutta-percha soon transmits carbolic acid. The "protective" Lister now uses is oiled silk; prepared by having a thin coating, brushed over it, of a mixture consisting of one part of dextrine, two parts of powdered starch, and sixteen parts of cold watery solution of carbolic acid—1 to 20. (*b.*) Antiseptic "lac-plaster" is laid evenly over the protective and should extend freely beyond the wound; and over both, the part is enveloped with a cloth, to absorb any discharge which may ooze from beneath the margin of the impermeable plaster, the cloth being secured in position by a roller-bandage. The plaster now used is incorporated with a soft cloth, instead of being spread upon starched calico. It is thus made more flexible and durable, but very thin; so that a double layer may be advisable, to double the store of acid in the application, when much discharge is anticipated, or when the dressing is not to be removed for some time. "The carbolic oil," and "carbolic paste or putty," formerly employed and advocated by Mr. Lister, he now seems to have almost abandoned. More recently, however, to complete the antiseptic appliances which may be requisite in the treatment of wounds, he has devised "antiseptic ligatures" of prepared catgut, for securing blood-vessels, and "antiseptic sutures," for retaining the lips and surfaces of a wound in contact.

Previously to applying the solid antiseptic dressing, above described, the wound is well syringed out with "carbolic solution or lotion," as strong as it can be made; one part of the crystals to twenty of water. The transient irritant property of this strong solution is said to be far less objectionable than the abiding influence of the more acrid products of putrefaction; even although the solution be thrown into the interior of a large joint, as in the dressing of a compound dislocation of the ankle-joint. A weaker lotion, one to forty, will suffice, in dressing a recent, and surgical, wound. The *skin* around a wound is well washed with the lotion. Then, the protective, lac-plaster, outer cloth and bandage, are severally applied.

Reapplication of the dressing may be required, or advisable, occasionally; in the intervals, the bandage and cloth may be daily mois-

tened with carbolic solution, strong or weak,—one to eighty, to renew a supply of the antiseptic to the lac beneath. Great care must be taken in removing the antiseptic dressing, not to admit air into the wound, or any regurgitation of discharge. Hence two precautions; in removing the cloth, the plaster should be held down over the wound, so as not to be drawn up with it, at any part where they may have become adherent by dried discharge; then, in raising the plaster, the nozzle of a syringe is inserted beneath its margin, and a stream of carbolic solution is thrown over the wound, until a piece of calico, soaked with the same lotion, has been placed upon it, as a temporary security, pending the re-application of the plaster. "These details, while essential to success, are, happily, easy of execution."

Theory of the Antiseptic Treatment.—To form an impartial judgment respecting the efficacy of "antiseptics," it is necessary, as in all other aspects of surgery, to draw a sharp line of distinction between observed facts, and their supposed explanation or interpretation. The non-recognition of this obviously important distinction has influenced, both favourably and unfavourably, the practice of antisepticism. To prevent, if possible, the putrefaction of animal matter, whether as blood or discharge, in contact with wounds, is known to be most important, pathologically, as an observed fact; and that carbolic acid has some such influence, is another observed fact. But how it operates is doubtful. Opinions are divided, though not equally.

The *chemical* theorists attribute the putrefaction observed, to the decomposition induced by the oxygen of the air, a process of oxidation.

The *germ*-theorists attribute the putrefaction observed, to the production of living organisms developed from germs or ova floating in the atmosphere, as constituents of its dust; and not as the result of "spontaneous or equivocal generation," in the putrifying animal matter.

The balance of *evidence* would seem to be in favour of the latter or germ-theory. The observations of Cagniard Latour, 1836, in the discovery of the yeast plant, followed by those of Schwann of Berlin, in the following year, and the subsequent discovery of minute, jointed, living bodies—vibrios—in putrid matter, supplied the basis of the germ-theory; while the well-known power of the atmosphere to carry and disseminate seeds or dust, completed the theory. The researches of Pasteur seem to have brought it to actual demonstration. Hence, antiseptic treatment would consist in excluding the atmosphere from wounds, and in interposing some agent which shall destroy the germs in their introduction by any exposure to the air. Has carbolic acid, or other so-called antiseptics, any such effect? The question is still *sub judice*.

Results.—Comparing the aggregate results of amputations, in the Glasgow Royal Infirmary, Professor Lister finds the mortality to have been:—Before the antiseptic period, 16 deaths in 35 cases, or 1 death in every $2\frac{1}{5}$ cases; whereas, during the antiseptic period, it was 6 deaths in 40 cases, or 1 death in every $6\frac{2}{3}$ cases. This is certainly a greatly dimished mortality, and its significance is more notable from the relative death-rate of amputations in the upper limb; where generally, neither the injuries nor the operations involve much loss of blood or shock to the system, so that if death occurs, it is commonly the result of the wound assuming an unhealthy character. There were

12 amputations in the upper limb, in each of the periods referred to. Of the 12 cases before the antiseptic period, 6 died; but of the 12 during that period, only 1 died, and 11 recovered. The deaths were caused, principally, by pyæmia, erysipelas, and hospital gangrene. Thence, it would appear, may be inferred "the effects of the antiseptic system of treatment upon the salubrity of a Surgical Hospital." * But my long experience at the Royal Free Hospital is decidedly in favour of those precautionary hygienic arrangements, with reference to cleanliness and ventilation especially, which may be denominated *pre*-septicism, and which render the antagonistic measures of *anti*-septicism quite useless, and, indeed, unnecessary.

After-dressing.—An incised wound should not be disturbed inconsiderately during the process of adhesion. Inflammation can scarcely be said to supervene. In the first instance, it starts this reparative process. Attended with a slight pouting and redness of the lips of the wound, this salutary degree of inflammation should not be repressed; and, being transient, inflammatory fever is not excited, from first to last, if the wound, however extensive and deep, continues to heal by adhesion. The constitution remains calm and impassive throughout the process, taking little or no notice of the local reparation effected by the part itself. Consequently, no antiphlogistic treatment, topical or general, becomes necessary; but the lightest dressings to maintain apposition, and the gentlest handling in applying them, are still sufficient.

The first dressing is not unfrequently the only one nature requires; the wound healing in two or three days, possibly in twenty-four hours. But union is not then secure, nor much before the end of a week in small wounds, and a fortnight in larger incisions. Therefore, during even the shortest period requisite for sound union, the dressings must be changed occasionally; their reapplication having reference always to some obvious and important purpose. Cleanliness, rather than readjustment of the wound, is the guiding maxim for interference. The strip of lint is to be withdrawn wet, not to disturb the lips of the wound, as yet tenderly united. The strips of plaster, also moistened to facilitate their removal, are withdrawn by both ends together gently towards the line of incision, not to undo the work of nature; and each strip is replaced by a fresh one before the next is removed, not to leave any part unsupported. To moisten the dressings, a piece of lint is preferable to a sponge, which might be accidentally re-used in another dressing, or from another patient; and in cleansing the wound, a light stream of tepid water should be squeezed from the lint, to wash away, instead of wiping off, any discharge. The removal of sutures, if any, will be guided by the progress of adhesion, or by the accidental supervention of inflammation. Within the first twenty-four hours, *some*, at least, may become useless, or worse,—irritating. These sutures should be picked out, wherever, from point to point, union appears safe, or the blush of inflammation is conspicuous. Otherwise they will ulcerate their way through, and so peril the healing progress. In the event of considerable swelling and tension, the lips of the wound having a tightly puckered appearance at the point of each suture, and a pouting or protruding condition in their intervals, *all* the sutures must be

* I gathered the foregoing description of the antiseptic treatment, and its results, from several monographs which Mr. Lister kindly forwarded to me for this purpose, in the first edition of this work.

withdrawn forthwith. If thus released, the lips do not adhere; the surfaces may do so, partially or entirely. But if the parts be heavy, and pendulous, as the under-flap of a thigh-stump, yet without tension, all the sutures had better be left in this, the first dressing.

The removal of any ligature or ligatures is, like their application, not necessarily part of the treatment of an incised wound; and will be considered under Wounds of Arteries.

The bandage, if any, and the compresses, if any, are no longer needed when union is sufficiently firm not to risk straining the parts, by the loss of these surface-supports. Generally, the first few days will suffice. Swelling, however, as in amputation-wounds, may yet require the partial support of a turn or two of the bandage, until tension has subsided.

Thus, one by one, the appliances of Surgery are withdrawn; one by one, these artificial props are removed; until at length, and ere long, in most cases, nature is able to consolidate the union, without further assistance.

Such then is, what I would term, the "conservative" treatment of incised wounds; an example, from first to last, utterly opposed to meddlesome Surgery.

Wounds of Arteries and Veins.

These Lesions are conveniently taken next in order.

Wounds of Arteries.—*Structural Conditions.*—A wound of an artery, like that of any other texture, may be incised, or lacerated; either of which lesions may be partial or complete.

Incision, *partially* extending through the calibre of an artery, and practically equivalent to a punctured wound, varies in *direction;* being longitudinal, oblique, or transverse, and these are important practical distinctions (Fig. 87); so also is the variation in size of an aperture, which may be of any circumferential extent, short of *complete* division of the vessel.

Fig. 87.

Laceration, *partially* extending through the coats of an artery, is limited to one or more of its three coats; the external, and more or less of the middle coats, may be torn through, leaving only the thin inner one entire; or, the two inner coats are severed, leaving only the thick external cellular coat untorn. This latter condition of laceration is effected by the surgical application of a ligature. Lastly, all three coats are torn through, if the laceration be *complete;* but the external cellular coat and cellular sheath, being tougher than the two inner coats, are drawn out from off them, which also retract; thus forming a canal of loose cellular tissue.

The *Signs* of any such wound of an artery are *hæmorrhage*, the blood having a florid red colour, and jetting out from the vessel, *per saltum*, with each beat of the heart; not escaping in a continuous stream of purple or black blood. The force and, in a degree, the rapidity of

the jets are regulated by the size of the artery, or of the aperture in it, by its proximity to the heart, and by the heart's action; also by the presence or absence of certain conditions which retard or favour the free flow of blood through the vessel. Thus, pressure on the proximal portion of artery retards, while a dependent position favours, the hæmorrhage. The blood coming from the *distal* portion of vessel is dark, and runs in a trickling stream, excepting from certain arteries, the palmar and plantar arches, which when wounded, jet arterial blood from either extremity of the vessel.

Causes and Effects of Wounds of Arteries.—An artery may be incised or cut with a sharp instrument, punctured with a pointed one, contused or lacerated by a blunt one, or wounded by force of a bruising or wrenching kind.

The operation of any such lesion *locally*, is to produce aneurism, if the blood be imprisoned in the textures; constituting *traumatic aneurism* —diffused, or eventually circumscribed. Its formation will be specially described in connection with aneurism. *Constitutionally* regarded, whether arterial hæmorrhage takes place externally, or internally, as into one of the great cavities of the body, its effects are manifested by *syncope* or fainting, more or less complete. And this may occur either by failure of the heart's action—*cardiac* syncope, and thence of the circulation, or as loss of consciousness—*cerebral* syncope; or both modes of process may be produced. The symptoms of syncope are further evinced by a feeble or imperceptible pulse, with pallidity and cold-clamminess of the surface, and lividity of the fingers, toes, lips, and eyes; in this condition, after a few oppressive sighs or gasps, with convulsive twitchings of the limbs, death may take place immediately. Or, if the hæmorrhage be less considerable and sudden, the symptoms of syncope are less marked; the patient turns pale and chilly, faint and sick, but soon becomes restless, and tormented with a raging thirst. These constitutional effects and the probability of death resulting, are proportionate to the quantity of blood lost; not necessarily by its escape *from* the body, but even when lost *to* the body as blood in circulation. Providentially, however, the imminent peril of continued hæmorrhage is lessened by cardiac syncope; suspension of the circulation tends to arrest the escape of blood from the artery, and by thus favouring the formation of an occluding clot, it tends also to arrest the hæmorrhage.

Reaction after loss of blood signifies the return of the heart's action and the circulation. This state is denoted by symptoms of vascular and nervous excitement, which, after considerable loss of blood, constitute *hæmorrhagic fever.* The pulse becomes rapid, but feeble or jerking, and irregular, loose or thready also in proportion to the anæmic condition of the blood-vessels. With returning warmth of surface, the face flushes, and the eyes acquire a lustrous brilliancy, while a restless excitement supervenes, bordering on delirium, and which perhaps terminates in death by coma and convulsions. Or the reaction may be intermittent; pallidity and syncope recurring, followed by some return of the circulation. Age much affects the issue. In youth, the rallying power is greater, though the tolerance of hæmorrhage is less, the loss of a small quantity of blood, as from a leech-bite, sometimes proving fatal to an infant; in advanced life, reaction is less vigorous, and as the reproduction of blood is also less active, recovery

will be more and more doubtful, death perhaps ultimately taking place from exhaustion, or from some secondary affection of a typhoid character. Arterial hæmorrhage is of greater consequence than venous. *After death*, the appearances presented are remarkably anæmic; the surface generally blanched, of a yellowish white, semi-transparent cast, but the finger-nails, toes, and lips are congested and livid.

Secondary hæmorrhage is so named where the bleeding occurs, or recurs, after an interval of a few hours, more or less, subsequent to the vascular lesion. (See AMPUTATIONS—*Stump*.)

The *Hæmorrhagic Diathesis* signifies a constitutional predisposition, whereby the slightest breach of surface—a scratch or a prick—is attended with a persistent oozing of blood ; the blood-vessels apparently possessing no contractility, and the blood no power of coagulation. From Wachsmuth's observations, it would seem that an exalted vitality of the blood, and a delicate organization of the capillaries, are the essential causative conditions. This diathesis is usually congenital, and perhaps hereditary, but it may be declared for the first time in adult life. Privations seem to induce the hæmorrhagic tendency, but it is often manifested in otherwise healthy constitutions, and apart from any adverse hygienic circumstances. Both sexes are equally liable, although in male children the hæmorrhages begin earlier and are more fatal. Marriage on the male side does not appear to transmit the diathesis. If the bleeding be spontaneous, as often in epistaxis, it may be periodic. Ecchymoses in various parts of the body, and internal extravasations of blood, are apt to occur. Joint-affections also are not uncommon, simulating rheumatism, and which temporarily control the tendency to hæmorrhage.

Reparation.—If the artery be healthy, any lesion is uniformly disposed to heal by coagulation of the blood and the formation of a clot or clots so placed as to arrest the hæmorrhage; a temporary provision, followed by primary adhesion, or, possibly, adhesive inflammation, whereby the vessel is permanently secured and obstructed. But this process of coagulation and adhesion is *modified* chiefly according to the structural kind of wound—incised or lacerated, either of which may also be a partial or complete division of the artery. Then, again, the direction of the wound more particularly modifies the process of healing.

(1.) An *incised* and *partial* division, or a *punctured* wound, of an artery is the simplest instance. (See Fig. 87.) If the direction of the cut be *longitudinal* or oblique, it will close more readily than a transverse incision, the edges of which gape and do not fall into apposition. The elasticity of arterial tissue longitudinally makes all the difference, and in favour of *that* direction, aided also, in this case, by the circular contractility of the artery. The line of incision remains closed; blood escaping coagulates betwixt the vessel and its sheath, forming a compress, assisted by any corresponding coagulum which may have formed outside the sheath. The relative positions of the apertures in the artery and its sheath are displaced somewhat by the formation of the intervening portion of clot-compress, thus further tending to arrest hæmorrhage. But this clot-compress is a temporary provision only. Adhesion soon follows in the line of incision, the edges being in contact. A *transverse* cut, partly through the circumference of an artery, opens, the vessel contracting longitudinally by virtue of its elasticity. Adhesion cannot ensue. The aperture is closed by the effusion and

organization of lymph *within* the artery, which thus becomes impervious and obliterated. Lost, however, for ever as a blood-conveying tube, hæmorrhage of perhaps fatal character is arrested. Nature is still victorious. The *size* of the vessel will somewhat affect the issue, which is otherwise in favour of a longitudinal incision. An artery like the temporal, with a longitudinal slit, heals without obliteration. An artery of larger calibre, and similarly wounded, becomes impervious and obliterated. And the ultimate success of Nature's effort is apt to be marred, even when the wounded vessel remains pervious; for the internal and middle coats not adhering firmly, this defect predisposes to aneurism.

(2.) *Complete* division of an artery by incision is healed by a modification of the same process—clot-formation, but not as a compress, being the temporary provision, and lymph-effusion permanently plugging up the vessel. Immediately after its division the artery retracts by its elasticity—longitudinally into its sheath, which thus projects loosely; and the mouth of the vessel contracts, even to a pinhole opening, owing to its muscular contractility—circularly. The retracted portion thus contracted has a conical shape, like that of a Florence oil-flask or French claret-bottle. (Fig. 88.) Contractility may be sufficient to close the vessel and prevent further hæmorrhage. In this way small arterial branches spontaneously cease to bleed in an open wound exposed to the air, or the action of cold water; but the artery having retracted, coagulation is induced within the loosely projecting filamentous sheath, which entangles the blood as it flows; and this event may be aided by cessation of the stream, owing to failure of the heart's action—cardiac syncope—another resource of Nature for the temporary arrest of hæmorrhage. Coagulation proceeds concentrically. The clot, at first pervious and transmitting a small central stream of blood, soon forms a solid mass, which, still enlarging, passes up the bore of the artery for a short distance in the shape of a small cone. This portion—internal coagulum or *bouchon*—and that in the sheath—external coagulum or *couvercle*—together form a clot, in shape like a glass stopper fitted into a decanter, to which the whole is compared by Professor Gross. The shape of Nature's product is not quite so finished off, for a small portion of the clot is insinuated between the sheath and artery beyond the point of retraction, thereby compressing the arterial aperture, while a still larger portion of an irregular shape projects beyond the aperture of the sheath. The whole clot is, however, continuous, and with these little offsets still bears the resemblance suggested. (Fig. 88.) The permanent closure of the vessel is effected by the effusion of plastic lymph. Like coagulated fibrin, its organization consists, essentially, of fibrils; but those of plastic lymph result from the elongation and attenuation of cells into fibres, in various stages of development. Corresponding in situation to the clot, *i.e.*, at the aperture, around it slightly, and extending into

FIG. 88.

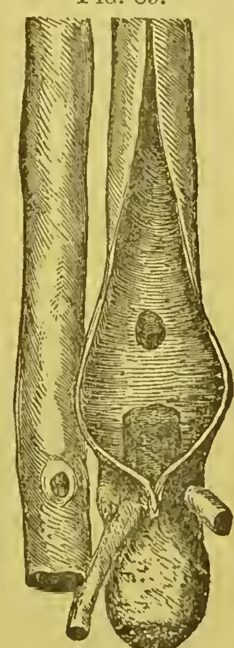
the vessel, the lymph intervenes between it and the clot, which it gradually replaces. During this change the clot varies in appearance, being partly lymph, and partly ordinary coagulum.

The lower end of a divided artery is closed up much in the same way. According to Guthrie's observations, it retracts and contracts less than the cardiac end; and the internal coagulum is altogether absent, or very imperfectly formed in many instances.

(3.) A *lacerated* wound of an artery, if *partial*, may extend through the external and middle coats, leaving only a thin undivided inner membrane, which still continues the channel of communication. Hæmorrhage is imminent. Or the laceration may extend through the inner and middle coats, leaving the outer cellular coat entire. Hæmorrhage threatens, or gangrene may supervene. But if the two inner coats be cut rather than torn, reparation generally takes place and secures the vessel. Such is the kind of injury purposely inflicted by the Surgical application of a ligature, which leaves the external coat undivided; and although itself noxious, as a foreign body in the very pathway of reparation, the artery becomes sealed with plastic lymph, plugged up also with coagulum, and obliterated. The details of this process, thus *artificially* induced by Surgical interference, will be described in connection with the *treatment* of hæmorrhage.

(4.) *Complete* laceration of an artery—all the coats being torn through—heals without hæmorrhage, or scarcely any. The process is the same as that which takes place after division of an artery by incision. But the cellular sheath and outer cellular coat are drawn off the two inner coats, which retract. Consequently the clot that forms in the projecting portion of loose sheath is larger than when the vessel is simply cut across; presenting a bulb-shaped extremity, which may extend to half an inch or an inch in length. This appearance is well shown in Fig. 89, which represents a popliteal artery and vein in a remarkable case, both vessels having been ruptured by a violent twist of the knee-joint. Gangrene of the leg ensued, for which I amputated above the knee; with, however, a fatal result.

Fig. 89.



Treatment.—Arrest of hæmorrhage is the first indication of treatment. *Small* arterial vessels spontaneously cease to bleed, almost immediately. Thus, if the vessels be divided entirely across—complete incision—as in most wounds, their cut extremities retracting and contracting soon offer adequate resistance to the escape of blood. This natural provision will be insured by exposure of the wound to cool air, or a stream of cold water squeezed from a sponge. Gentle pressure with the sponge will readily discover whether there be still any oozing from the bleeding points. *Larger-sized* arteries bleed in jetting streams of florid blood, and the further resources of Surgical treatment are forthwith necessary to meet such hæmorrhage. They comprise:—(1) Astringents, including Cold, and Styptics; (2) Cauterization; (3) Compression; (4) Ligature; (5) Acupressure; (6) Torsion.

(1.) *Astringents.*—*Cold* may be applied in various ways; in the form of a stream of cold water, or by exposure to cool air, or by means of an ice-bag, or as ice-water. Cold applications are most eligible for the arrest of general bleeding from a large surface, or in the event of persistent oozing hæmorrhage; and where the bleeding proceeds from an internal cavity, as the mouth, rectum, or vagina, when it may be arrested by the injection of ice-water. After a wound has been closed and dressed, the recurrence of hæmorrhage can often be stopped, either by a continued or a dropping stream of cold water by means of irrigation, or by the application of an ice-bag. *Styptics* are various astringent agents; such as styptic colloid, tincture of the perchloride of iron, Ruspini's styptic, oil of turpentine, solution of alum, tincture or infusion of matico. These agents are used by means of a brush or a fold of lint soaked in the styptic, and applied to the bleeding surface. Other styptics may be administered internally; as gallic or tannic acids, lead, opium, or turpentine. All such agents are appropriate under similar circumstances of hæmorrhage to those for the employment of cold. But external styptics are apt to induce a thin layer of slough, and thus prevent or intercept primary union. And internal styptics are hardly prompt enough in their action. Solid opium, given in a full dose, is accredited with the virtue of arresting any oozing of blood from a number of small vessels, after wound or operation. The hæmorrhagic diathesis also may perhaps be controlled by oil of turpentine.

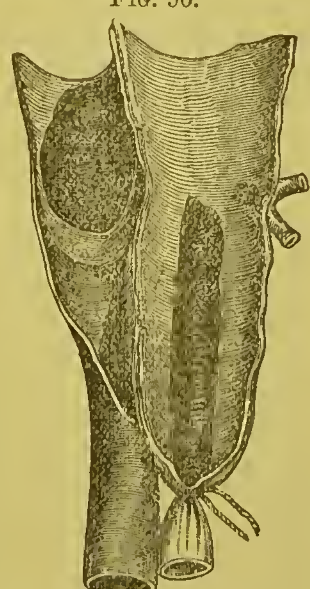
(2.) *Cauterization* may be effected by the *actual* cautery, or hot iron —the most ancient resource in surgical hæmorrhage, or by the *potential* cautery, in the form of potassa fusa or nitrate of silver. The actual cautery usually consists of an iron rod, having a conical-shaped or button extremity, the other end being set in a wooden handle. The iron is heated in the fire to a black heat, rather than made red-hot, and the point is then applied, almost momentarily, to the bleeding vessel, which causes a hissing sound, and produces an eschar, or slough, of the burnt textures. Other forms of actual cautery are sometimes employed; a porcelain instrument heated by gas, or platinum heated by means of the galvanic battery, the galvanic cautery. Cauterization is most serviceable when the hæmorrhage proceeds from one or more arterial points, and in an otherwise inaccessible situation. But on the detachment of the eschar, in about a week, bleeding is liable to return.

(3.) *Compression*—*mediate*, as it is sometimes termed, when not directly applied to the bleeding vessel—may be effected either by the finger or a *tourniquet*, placed over the parent artery, at the most eligible spot betwixt the wound and the heart. Pressure thus applied is only a temporary resource. *Immediate* compression is effected by pressure directly applied over, or to, the bleeding vessels. Direct pressure may be made *over* the seat of the bleeding vessels by a pad of dry lint or other material, secured in position with sufficient firmness by a roller-bandage. A wound having been thoroughly cleansed and closed, hæmorrhage can thus be arrested; and after amputation, the flaps of the stump can be compressed with a broad pad above and below, retained by the turns of a bandage. *Cavities* admit of being plugged with a pledget of lint or piece of sponge, saturated perhaps with some styptic solution; as in bleeding from the nares, rectum, or vagina, or from

the orbit after removal of the eyeball, or from the socket of a tooth, in the rare case of continued bleeding after tooth extraction. Direct pressure can be brought to bear, even more effectually, by means of a *graduated* compress, applied *to* the bleeding vessel. This form of compress consists of a series of pads of dry lint, from the smallest pledget which is placed on the bleeding point, over which another is laid down, and as many more, each of increasing size, as will reach above the level of the surface; thus making a conical-shaped compress, the apex resting upon the wound in the vessel, and the whole being secured by a bandage. In applying the first plug of lint, the cavity must be well sponged out, while the main artery is commanded above, that the bleeding vessel may be fairly seen, before laying down the compress. It represents the clot-compress of nature. The graduated compress should be allowed to remain until the wounded vessel has become closed without the risk of hæmorrhage recurring; the requisite period varying from about a week to a fortnight. This mode of direct compression is specially applicable to the wound of a single artery, and which cannot be secured otherwise; but direct compression, in either of the ways described, is suitable only, or chiefly, for the control of small arteries, and where the support of bone affords counter-pressure.

(4.) *Ligature.*—The ligature is a Surgical appliance in imitation of a lacerated wound, partially extending through the coats of an artery, *i.e.*, through its two inner coats, which are thin and fragile, leaving the thicker and tougher outer coat and cellular sheath untorn. The effectual operation of this appliance is compression of the vessel to induce coagulation of the blood stagnant above and below the ligature, and the effusion of plastic lymph, from the divided coats, to permanently occlude the vessel in both directions; sloughing of the included ring of outer coat and cellular sheath being rendered necessary to detach the ligature. The details of this reparative process, thus induced artificially, are these:—

FIG. 90.



The included portion of external cellular coat and sheath, having undergone continued compression, sloughs, and is detached with the thread, in a period varying from twenty-four hours or so to about three or four weeks, chiefly according to the size of artery. Hæmorrhage would then be inevitable; but, pending the detachment of this slough-ring, effusion of plastic lymph, from the vasa vasorum, takes place, whereby the two inner coats, divided, become adherent across the area of the vessel, just above and below the ligature. At these points they curl inwards when divided, and, converging, meet together.

This condition was well seen in a femoral artery and vein (Fig. 90), which I examined five days only after it had been ligatured when the thigh was amputated. A process of organization, therefore, above and below the ligature, accompanies the destruction and detachment of the ring of external coat embraced by the thread. Thus,

the artery is securely sealed. Accessory, but incidental only, to the prevention of hæmorrhage, are certain changes whereby either portion of the artery adjoining the ligature is obliterated. The vessel having ceased to convey blood when the ligature was applied, the blood stagnant above and below, to the nearest collateral branch, has gradually undergone coagulation in the shape of two conical clots, the bases of which accurately plug the artery on either side of the thread. The apex of the clot on the cardiac side tails off, usually opposite the first collateral branch above, through which the stream of blood, now diverted from its course, is carried off from the main. The distal clot is always less defined. At first either clot has the appearance of ordinary coagulum, subsequently it becomes mottled with paler spots, and its substance porous, and ultimately acquires a buff colour, firm consistence, and fibrous texture. Blood-vessels, proceeding from the lymph immediately above and below the ligature, shoot into the base of either clot, and gradually extend towards its apex. Finally, these organized fibrous clots are incorporated with the lymph adjoining, which has acquired a similar structure; the coats of the unused portions of artery degenerating, also assume a fibrous character; and the whole is converted into a small, firm, impervious, fibrous cord, extending usually to the first collateral branch above and below. Nature having safely severed the artery, under compression by the ligature, and securely sealed either end, has now obliterated the portions useless as a blood-conveying tube.

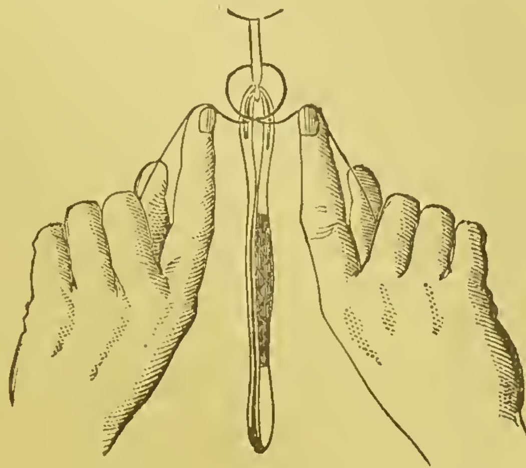
Certain advantages, and disadvantages, attend the use of the ligature. *Appropriate* for the arrest of hæmorrhage which would otherwise be persistent or recurring and perilous, the *objections* to ligature are:— the production of a slough or sloughs of arterial texture, according to the number of vessels ligatured—and thence the liability of secondary hæmorrhage; the introduction of a foreign body, or as many foreign bodies, into the flesh-wound—a condition which, in conjunction with that of the arterial slough-rings, is antagonistic to the process of healing by primary adhesion; and that suppuration consequently, and the sloughs, are provocative of pyæmia. The efficacy of ligature in the treatment of hæmorrhage from wounds of arteries, of flesh-wounds, and in relation to pyæmia, is to be estimated by all these considerations; and thence the value of this method of treatment as compared with that of "acupressure," proposed to supersede it.

Certain particulars are of great moment in the *application* of a ligature; the observance of which a due knowledge of the process which is thus induced for the arrest of hæmorrhage, can alone insure. It is in this light that I specially here advert to them. But they have reference also to the value of ligature, as a method of treatment; for they determine the probability of hæmorrhage recurring or supervening, and also of the healing of a flesh-wound by primary adhesion when an artery or arteries are thus secured.

The practical particulars having this twofold significance are these: —A ligature should be applied so as to *cut* through the two inner coats of the artery, leaving only the outer more-resisting cellular coat and sheath. Hence the ligature must be a small, round, and strong thread, fine silk twist waxed being found to answer best. Applied with sufficient tightness for this purpose; and also to induce sloughing of the outer coat by *strangulating* compression. Applied *transversely* across the diameter of the vessel, observing to press the loop down

well upon the vessel, with each forefinger, so as not to include the point of the forceps; and then, in tightening the loop, to press the threads in like manner, downwards, adjoining the loop, that its hold may be retained; tying them with a *reef-knot*. (Fig. 91.) Failing these precautions, with regard to the vessel, the ligature may shift its position, and loosening, hæmorrhage recurs or supervenes when adhesion is not yet sufficiently advanced to safely seal the vessel. For the same reason, a ligature should be applied so as *not* to include any *extraneous* texture —a bit of muscle, a vein, or nerve; for then the twofold effect on the artery enclosed may not be produced, or sloughing may proceed more speedily in the extraneous texture than in the arterial coat, the ligature become loosened, and hæmorrhage occur. Inclusion of a nerve-filament causes also great pain at the time, and for a considerable period in some cases. An imbedded artery may be inaccessible without including some other texture. In the most inaccessible situations —as when, by amputation, the anterior tibial artery is divided at its origin and deep in the muscles between the heads of the tibia and fibula —it is absolutely necessary to "dip" for an artery so placed. A curved needle armed with a ligature is in this way carried round the vessel, and the thread tied as usual, but including as small a quantity of extraneous texture as possible. On the other hand, the ligature should *not* be applied to any *projecting* portion of the artery; the vessel being there denuded of its own nutrient vessels (vasa vasorum), plastic lymph is not effused, and when the slough-ring separates, hæmorrhage is inevitable. Regarded as a *foreign body*, antagonistic to healing by primary adhesion, one end of the ligature is usually cut off close to the knot on the artery, leaving only the other end to command the noose, and thus reducing the quantity of foreign body in the wound by one half. The ligature or ligatures may be brought to one or other angle of the wound, and there fixed by a small piece of plaster, thus also limiting any defective adhesion to the narrow track occupied by the thread or threads.

Fig. 91.

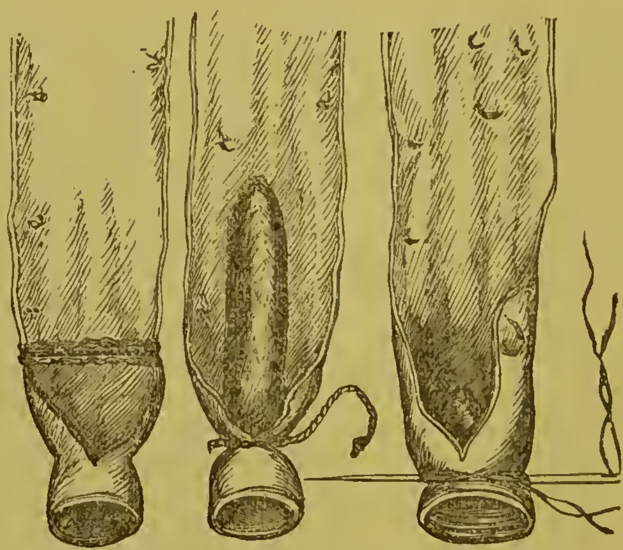


Duly observing all these suggestions of pathology, the constructive part of the process—adhesion—will generally accompany the destructive—sloughing—with even progress; permanent closure of the vessel accompanying the separation of a ring of slough with the ligature. The security of the vessel is safely ascertained by gently twirling the thread between the thumb and finger. A yielding sensation shows that Nature has done her work, and that the ligature detached can be withdrawn without the risk of hæmorrhage. This, however, cannot be expected, nor should the experiment be tried, before sufficient time has elapsed—the *period* varying from twenty-four hours to as many days or more, chiefly according to the *size* of the artery.

Ligature of an artery in its *continuity*, is fully described under Ligature of Arteries.

(5.) *Acupressure* has been proposed by Sir James Simpson as a substitute for ligature. It is essentially the "temporary metallic compression" of an artery, and it may be accomplished in either of three ways:—(1.) By passing a long needle twice through the flaps or sides of a wound, so as to cross over and compress the mouth of the bleeding vessel or its tube; just as in fastening a flower in the lapel of our coat we cross over and compress the stalk with the pin which fixes it, and therefore pass the pin twice through the lapel. In this method a long needle is introduced from the cutaneous surface, and its extremities left out *externally*. In both the other methods a common sewing-needle, threaded with iron wire, is used. The needle is introduced on the raw surface of the wound, and is therefore placed altogether *internally* or between the lips of the wound. The wire is only for the purpose of withdrawing the needle when no longer required. (2.) In one of the methods referred to, the needle is dipped down into the textures a little to one side of the vessel, then raised up and bridged *over* the artery, and finally dipped down again into the textures on the other side. This method, therefore, is the same as the first, but that the needle is applied altogether on the raw surface of the wound and over the artery, which it compresses. (3.) The third method consists in passing a needle *under* the vessel, transfixing the textures once. A

Fig. 92.*



loop of wire is passed over the point, and fastened round the eye end by a single twist, thus compressing the artery and some surrounding tissue between the needle and the wire. This method Sir James Simpson believes to be the one which will probably be most frequently practised. (Fig. 92.)

In one form or other, acupressure is said to be superior to ligature, both with regard to the improbability of *secondary hæmorrhage*, the

* Occlusion of Arteries; the femoral arteries, after Acupressure, and Ligature —in double amputation—each twenty-four hours. (Author.)

probability of *healing by adhesion*, and the improbability of purulent, or other septic *infection of the blood—pyæmia.*

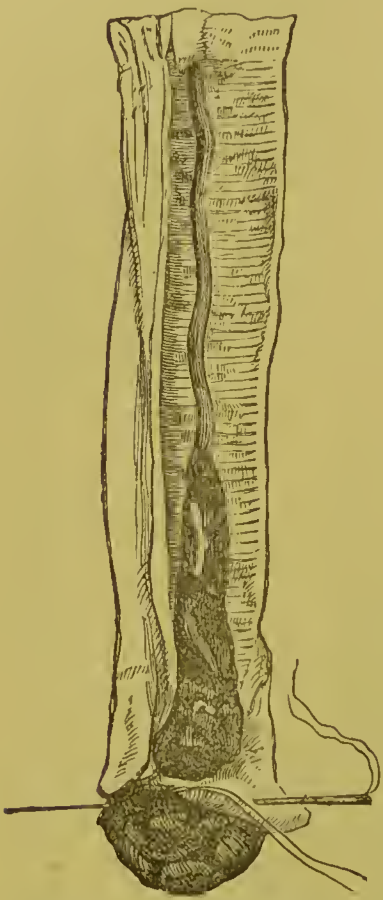
(*a.*) Respecting *hæmorrhage* after amputations, in eleven cases of acupressure only one was followed by secondary hæmorrhage; whereas in eleven cases of ligature, four of secondary hæmorrhage occurred, of which two were fatal. Such were the comparative results after amputations at the Carlisle Hospital (Hamilton's Report). In other words, in that institution, secondary hæmorrhage from ligature and from acupressure was as four to one in eleven cases. Other favourable results might be added. The most recent report is that of Professor Pirrie, who, with Dr. Keith and Dr. Fiddes, has more especially practised and advocated this mode of arresting arterial hæmorrhage. The former enumerates his experience in important cases, of which records have been kept, as comprising the following operations:—Eleven cases of amputation of thigh, four of amputation of leg, two of amputation of arm at the upper part of the surgical neck of the humerus, one of amputation at ankle-joint, one of Chopart's amputation, two of amputation of the whole of great toe, twelve of excision of mamma, six of excision of elbow-joint, one of excision of knee-joint, one of excision of an erectile tumour, one of excision of tumour on chest, one of excision of tumour on thigh (wound eight inches long), one of excision of head of fibula, three of excision of testicle, one of hæmorrhage from sloughing of hand, one of wound of hand, one of wound of upper part of forearm with great hæmorrhage, one of wound of radial artery, and one of wound of hand attended with great hæmorrhage; in all fifty-one cases, and in which he has acupressed 185 vessels.

But experience has not yet sufficiently accumulated to determine the relative value of these two kinds of treatment with reference to the improbability of hæmorrhage supervening. Nor has pathology hitherto determined this question. "We want," acknowledged Sir James Simpson, "a series of proper experiments and observations as to the actual *pathological mechanism* by which acupressure occludes the mouths and tubes of arteries, before we can attain fixed ideas as to its progress and completion." Accordingly, in the year 1867, I endeavoured to supply this *desideratum* by post-mortem examination of the process of occlusion in arteries, after acupressure, and its relation to the treatment of surgical hæmorrhage, compared also with ligature and torsion. The results of my observations were communicated in a Paper to the Clinical Society, in 1871. Previously, the observations of Mr. H. Lee and Mr. J. W. West, respectively, relative to acupressure were brought before the same Society. The practical object of my inquiry was, by a due knowledge of the *process* of occlusion, to determine the proper period for the safe withdrawal of the needle from a main artery, as the femoral, and the various periods in respect to different-sized arteries; rather than having recourse to the perilous mode of investigation, by tentative experience on living patients, in the treatment of hæmorrhage by acupressure. Thus would be determined the liability of secondary hæmorrhage occurring in this mode of treatment.

Occlusion, after acupressure, consists, essentially, in the formation of a conical clot, adjoining the transverse line of acupressure, or needle; this clot increases in length, extending up probably to the first collateral branch of artery, and it increases also in calibre, so as to completely occupy the bore of the vessel at, and for some distance adjoining,

the line of acupressure. Thus the artery is plugged. (Fig. 93.) This clot soon undergoes structural changes; becoming fibrinous in its distal portion, partly fibrinous, eventually perhaps entirely so, in its proximal portion, and there adherent to the interior of the artery. Further changes I have not yet traced. But it would seem highly probable that the occluded portion of artery atrophies, and degenerating into a fibro-cellular cord, as after ligature, thus becomes permanently obliterated. In conjunction with this series of changes, as affecting the blood in the artery, and eventually the vessel itself, there are, however, no changes at the seat of acupressure—no division of the inner and middle coats of the artery, and their inversion or reduplication, and no subsequent deposition of lymph with adhesion of the divided coats of the vessel; the integrity of the artery remains unaffected by the compression of acupressure, temporarily applied, the needle serving the purpose merely of preventing the escape of blood as primary hæmorrhage, while, by arrest of the passage of blood, coagulation may be induced, and thus secondary hæmorrhage prevented when the needle is withdrawn. A firm, fibrinous, and adherent clot was found to have formed within five days, and in a main artery—the femoral.

Fig. 93.*



In *treatment* by acupressure, therefore, the proper period for the safe withdrawal of the needle may be inferred to be at that period, if not earlier; without liability to the occurrence of secondary hæmorrhage.

(*b.*) Respecting the probability of *adhesion* taking place between the *surfaces* of a wound, the arteries of which are secured by acupressure; it is alleged that the needles are, as foreign bodies, merely temporary, while their material is less irritating than that of ligatures; and that they are not intended or allowed to produce sloughing of the compressed arteries, whereby foreign bodies of worse character, in the shape of slough-rings of the cellular coats of these vessels, are produced and remain between the raw surfaces—with, moreover, suppuration. (*c.*) Hence, also, the greater probability, apparently, of *pyæmic infection* supervening after ligature. And certainly the observations of Professor Pirrie are here to the point, not a single instance of pyæmia having occurred in his experience where acupressure has been employed by himself or his Hospital colleagues at the Aberdeen Hospital.

(6.) *Torsion of cut arteries* is another method of arresting hæmorrhage, which may be regarded as an imitation of another natural process

* Occlusion of femoral artery after Acupressure—in amputation—five days. (Author.)

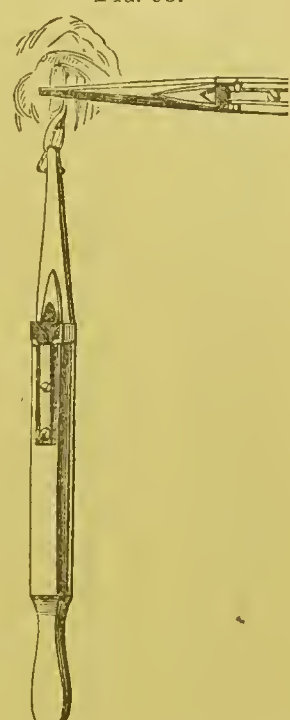
of cure. Torsion is effectual by laceration of the two inner coats of the cut end of a bleeding artery, the outer coat remaining as a loose filamentous sheath, which, entangling the blood and forming a peg, is equivalent to an accidentally *complete* laceration.

This procedure, originally noticed by Galen, was revived about 1828; in France, by Amussat, Velpeau, and Thierry; and in Germany, by Fricke. In this country, recently, torsion has been practised more generally, and it seems to be attracting increasing attention. Arteries of *small* size had long since, occasionally, been commanded by a pinch and twist with the forceps; but *large* arteries, as the femoral, brachial, ulnar, and radial, have been effectually secured by torsion, in amputations of the thigh, arm, and forearm, as previously practised by Amussat and Velpeau.

Occlusion by Torsion has been specially investigated by Mr. Cooper Forster, whose observations are published in the Trans. Clin. Society, 1870. My own observations in one case, death taking place in thirty-six hours, were communicated to the same Society, in 1871. Occlusion consists in the following changes:—At the seat of torsion, the two inner coats of the artery are torn across, and reduplicated up the vessel, perhaps in the form of a complete funicular sheath, one-fifth of an inch in length; and at the upper or smaller opening of this reduplication, or funnel, a conical blood-clot forms, occupying the bore and extending up the vessel. (Fig. 94.) The twisted condition of the artery, itself usually a persistent change, and the reduplicated sheath of the two inner coats, above, acting as a valve, are quite sufficient provision against the recurrence of hæmorrhage at the time of operation and subsequently; but there is also the supervention of clot-formation from this sheath, and extending further up the bore of the vessel.

FIG. 94.*

FIG. 95.



Different *modes* of torsion have been recommended, and are practised. The artery may be drawn out for about half an inch by one pair of serrated forceps, and its attachment seized by another pair of serrated forceps; the free portion is then twisted off by about a dozen turns of the former instrument, the method of Amussat. (Fig. 95.) Or, the end of the vessel may be simply twisted several times, without detaching it, as recommended by Velpeau and Fricke. This is the method I ordinarily practise, scarcely ever employing ligature to any

* Occlusion of brachial artery after Torsion—in amputation—thirty-six hours. (Author.)

artery, of whatever size, and it is, I believe, generally preferred. *Torsion-forceps* are now in general use; an instrument furnished with transversely serrated points, and closed by a slide when the end of the vessel has been seized. (Fig. 95.)

Comparison of Ligature, Acupressure, and Torsion.—The *occlusive process*, in the changes which the artery and contained blood undergo by ligature, acupressure, and torsion, may be thus summarily stated:—Firstly, in all three, conical clot-formation and plugging of the vessel, adjoining the line of compression, or of twist; and, in acupressure, this is the only provision against the supervention of hæmorrhage, when the surgical appliance, the needle, is withdrawn. Secondly, in both ligature and torsion, division of the inner and middle coats of the artery, transversely, at the line of operation; followed by lymph-deposition and sealing of the vessel. This is the only additional provision against the supervention of hæmorrhage, when the ligature separates: but in torsion, the twist of the vessel is persistent, and reduplication of the divided coats, probably in a funicular form, acts also mechanically as a valve, against the occurrence of hæmorrhage. In relation to the *treatment of hæmorrhage*, the formation of a clot-plug might seem an insufficient provision to prevent its recurrence, when the needle is withdrawn after acupressure, so that secondary hæmorrhage would then take place; yet the results of experience, already referred to (p. 381), have shown that this single provision is sufficient, without the additional security of lymph-deposit and sealing of the vessel, as at the line of ligature or of twist; or the extra and mechanical security afforded by the persistency of the twist, and the funicular valve of lining membrane. But assuming the liability to the occurrence of secondary hæmorrhage to be about equal after either of the three methods of surgical treatment, the tendency to *primary union* of the flesh-wound, and the prevention of *pyæmic infection* of the system, must be very different. Torsion has decidedly the advantage over either ligature or acupressure, in regard to both these very important considerations. The twisted portion of an artery not being killed, as its subsequent adhesion shows, no sloughing of the end of the vessel ensues—when this portion is allowed to remain in the wound; yet this event necessarily and intentionally ensues after the application of ligature, or accidentally by prolonged acupressure; and no other foreign body is allowed to remain in the wound, for however short a period, to possibly provoke suppuration, as after both these methods of treatment.

WOUNDS OF VEINS.—The same forms of injury may occur as those to which arteries are liable, and they having been already sufficiently described, need not be repeated.

The *Signs* of any such wound are venous hæmorrhage; the blood of a purple or black colour, and flowing in a continuous stream, unlike the jetting of florid red blood from an artery. The size of the stream soon diminishes, and hæmorrhage may be arrested, by collapse of the thin walls of the veins; while any return flow from the cardiac end of the vessel is stopped by the valves, unless when the bleeding proceeds from valveless veins, as those of the portal system. Veins of the largest calibre, as the internal jugular, subclavian, axillary, and femoral, continue to bleed copiously; but the stream is intermittent during inspiration, and accelerated by expiration. The force and, in some degree, the rapidity of the stream are regulated by the size of the vein, or of

the aperture in it, by the heart's action, and its effect on the flow of venous blood; and by the presence or absence of certain conditions which favour or retard the free flow of blood through the vessel. Thus, pressure on the vein between the aperture and the heart, a dependent position of the part, and muscular action in the course of the current, favour the hæmorrhage; while the opposite conditions retard it.

Causes, and Effects of Wounds of Veins.—Like an artery, a vein may be incised or cut with a sharp instrument, punctured with a pointed one, contused or lacerated by a blunt one, or injured by force of a bruising or wrenching kind. The operation of this lesion, *locally*, is to induce diffuse inflammation of the vein—diffuse phlebitis, if the wound be an open one, or to produce a collection of venous blood—blood-tumour, if the fluid be imprisoned in the textures. This condition will be described under Contusion. *Constitutionally*, whether venous hæmorrhage takes place externally, or internally into one of the great cavities of the body, its effects are manifested by *syncope;* either by failure of the heart's action—cardiac syncope, and thence of the circulation, or by loss of consciousness—cerebral syncope; or by both these effects, and their fatal termination if the hæmorrhage be sufficiently prolonged. These constitutional effects, and the probability of death resulting, are proportionate to the quantity of blood lost; not necessarily by its escape from the body, but even when lost to the body as blood in circulation. Such consequences are less apt to ensue from venous than from arterial hæmorrhage; but another constitutional disturbance is *specially* liable to occur from an open wound of a vein, and more so, the larger the vessel. Air is apt to enter the circulation, attended with a whirling, bubbling, sucking, or lapping sound; the individual feels death-struck, he moans and breathes heavily, becomes very faint, and probably dies, in a few minutes, or, at the most, in a few hours.

Reparation.—Wounds of Veins heal by processes apparently analogous to those whereby similar Wounds of Arteries are repaired.

Treatment.—The arrest of venous hæmorrhage may be accomplished, by an elevated position of the part, and the pressure of a compress secured by a few turns of a roller. Cold or astringent lotions are also of some service. Ligature should be avoided, as being apt to induce phlebitis. But this resource may be necessary in the case of a large vein, or if the vessel be so situated that pressure cannot be applied.

The treatment of diffuse inflammation of a wounded vein will be considered under the head of Phlebitis; and the remedial measures appropriate to the formation of a blood-tumour, in connection with Contusion.

Constitutional Treatment of Hæmorrhage.—*Arterial* or *Venous.*—After the loss of any considerable quantity of blood, whether by accident or surgical operation, the patient should be laid in the recumbent position, to prevent syncope; and afterwards, rest in this position will be favourable to the weak circulation. The circulation should be restored, in the first instance, by the judicious administration of stimulants and warmth, as in the case of Shock; but subsequently, nourishing food will be required, especially in the liquid form, to regain the blood lost, and the bulk of the circulating fluid. In the chronic anæmia resulting from severe hæmorrhage, iron and quinine

lend their aid, as the most effectual tonics; though this condition often lasts perhaps for life, as an incurable cachexia.

Transfusion of Blood.—This operative procedure offers an ultimate resource, justifiable only in extreme hæmorrhage; not, however, to be delayed until the patient is dying, nor declined on that account, recoveries having occurred when the patient was lying *in articulo mortis.* The *operation* consists in the injection into a large-sized vein, at the bend of the arm or instep, of a variable quantity of blood—six to sixteen ounces—freshly drawn from the vein of a healthy man or woman. Blundell's transfusion apparatus, or Dr. Roussel's instrument, is perhaps the safest and most convenient; but transfusion may be effected by means of an ordinary glass syringe, fitted with a stop-cock, and a cannula. A clean glass vessel is used to receive the blood, this vessel being rather deep to retard coagulation; and both it and the injecting syringe are warmed up to blood temperature, 98°. The patient's vein having been opened by an incision just large enough to admit the cannula, and the blood having been drawn from the arm of another person into the vessel, the injecting syringe is then filled with blood, and the nozzle being inserted into the cannula, the vital fluid is passed into the circulation, in a slow and equable stream. In this procedure, three other particulars must also be observed:—that the blood injected does not approach to coagulation; that no bubbles of air be thrown in; and that the vein be not injured by the cannula. If blood cannot be procured, warm water may be injected. The results of transfusion have been successful, occasionally, in saving life, for a time, at least, or even to complete recovery. First practised by Dr. Blundell in cases of flooding after child-birth, this method of restoration has since been resorted to in extreme surgical hæmorrhage; notably in a case by Mr. Lane, where a boy was thus rescued, and who after an hour or two sat up in bed with no return of the bleeding. Dr. Roussel, of Geneva, has more recently practised transfusion with much success.

Entrance of Air into Veins.—The fatal result or the extremely perilous symptoms arising from the forcible introduction of air into the veins of animals, had long been known; and was at length made the subject of experimental observation by Morgagni, Valsalva, Bichat, and Nysten. But, in Surgical Practice, the accident first occurred in the experience of M. Beauchesne in 1811, during an operation for the removal of a tumour from the lower part of the neck. It was necessary to disarticulate and raise the clavicle; and while this was being done, the patient became faint, exclaimed, "I am dying," and expired in less than a quarter of an hour. Dissection revealed a small wound in the internal jugular vein at its junction with the subclavian, and the entrance of air through that wound caused the fatal result. The accident has since happened in the practice of Mirault, Clemot, Roux, Majendie, Castara, Dupuytren, Delpech, Bégin, B. Cooper, Warren, Mott, Stevens, and other Surgeons, both in Europe and America. A Commission of the French Academy was appointed to investigate the subject; and the names of Majendie, Amussat, Wattmann, and Cormack, are distinguished for the light their labours have thrown on the pathology of the entrance of air into veins.

Symptoms.—The *local* phenomena consist in a peculiar sound, of a hissing, gurgling, lapping, or sucking character, produced by the

entrance of air, with the appearance of bubbles about the wound in the vein. The *constitutional* effects are equally remarkable; the patient is suddenly seized with great oppression in breathing, and extreme faintness, convulsive struggling, and a horrible feeling of terror and impending danger, inducing him to exclaim that he is dying. A churning noise is heard in the heart, synchronous with the ventricular systole; and the hand applied to the chest, perceives a peculiar bubbling, thrilling, rasping sensation, produced by the air and blood being whipped together within the ventricle. The heart's action becomes extremely feeble, and the pulse almost imperceptible. When only a small quantity of air has entered the circulation, the symptoms may pass off and the patient rally. A larger admission of air speedily causes death, during the convulsive struggling, or without convulsions, as if by simple syncope. The *period* at which death occurs varies, from a few moments or minutes, to several hours. When the patient survives, some hours elapse usually before consciousness and strength are restored. In some cases, after recovery from the immediate effects of the accident, death has ensued from pneumonia.

The *mode* of death seems to be essentially asphyxia, by the impaction of air-bubbles in the capillaries of the lungs, mechanically obstructing the pulmonary circulation; thence arresting the systemic circulation, and the supply of arterial blood to the brain, followed by syncope. But the heart's action continues, after respiration has ceased; and at last failing from want of its necessary stimulus, arterial blood, this organ is the *ultimum moriens.*

Cause.—Air is liable to enter the veins only during each act of inspiration; and in consequence of a tendency to the formation of a vacuum within the thorax, more particularly in the pericardium, during inspiration. Thence a sucking action, or "venous inspiration," in the veins within and near the thoracic cavity; extending to where the coats of the veins collapse. This area is limited to that part of the root of the neck and axilla where the venous flux and reflux of blood are perceptible, and the space in which it occurs has been called "the dangerous region."

Various circumstances favour the admission of air into an open vein:—1. The site of the wounded vein being in the dangerous region. 2. Canalization of a vein; owing to its coats having become thickened by morbid deposit, or adherent to condensed, consolidated surrounding textures, or by the spasmodic contraction of muscles; either of these three conditions having the effect of converting a vein into a rigid, uncollapsing tube. 3. Traction on the vein. 4. A stretched position of the part operated on. 5. The form of the wound. 6. The position of the vein in the wound; a vein cut in the corner of a wound being apt to gape, as Dupuytren's case demonstrated. 7. Deep inspiration.

Treatment.—*Preventive* measures consist in making pressure on the cardiac side of the wound, during operation in dangerous localities; and keeping the part in a relaxed position, thus to prevent the veins being drawn open. Any vein of considerable size, and especially in which the venous pulse is perceptible, should be avoided as much as possible. Feeble inspiration is desirable, and this is best secured by the influence of chloroform; tightly bandaging the chest to prevent deep inspiration, as some have recommended, is a perilous precaution.

Curative treatment comprises the fulfilment of the following indications:—1. To maintain an adequate supply of blood to the brain, for the prevention of death by syncope. The patient should be placed recumbent, with the head low, and pressure should be made on the axillary and femoral arteries, so as to direct the circulation towards the brain. 2. To maintain the action of the heart by artificial respiration, and friction at the præcordial region. 3. To promote the removal of obstruction in the pulmonic capillaries, also by artificial respiration. 4. After recovery, to treat the tendency to inflammation of the lungs.

CHAPTER XVII.

CONTUSION.—CONTUSED AND LACERATED WOUNDS.—PUNCTURED WOUNDS.

CONTUSION.—*Structural Condition.*—Contusion is a laceration of the *soft* textures, *subcutaneously*, the skin remaining unbroken; whereby the textures, thus injured, are protected from the action of the air. This kind of lesion, therefore, is the connecting link between other subcutaneous lesions, by laceration, as simple fracture and dislocation, and openly lacerated, or contused wounds, compound fracture and similar dislocation; the turning point being exclusion from, or exposure to, the action of the air. Subcutaneous laceration of the soft textures is necessarily attended with some hæmorrhage, also beneath the skin, but which extends inwards according to the depth of the contusion. The *degree* of laceration is proportionate to the force applied externally, and to the molecular cohesion of the textures affected; the quantity of blood effused is regulated, partly by these circumstances, but chiefly by the vascularity of the textures; while the effusion is finally determined by the resistance offered by the textures which, with the blood accumulated, together act as a compress upon the lacerated vessels. The vessels become more or less occluded with fibrinous clots; or this state of thrombosis may perhaps be induced by contusion of the walls of the vessels, Brücke having shown the influence of a healthy state of the walls in maintaining the fluidity of the blood within the vessels.

Signs.—The blood, diffused into the textures interstitially, and especially into the cellular tissue, is said to be *extravasated;* instead of being discharged out of the body as in ordinary hæmorrhage. Any portion of the blood which has accumulated in the cellular tissue under the skin, is made visible through the integument; and hence the appearance of a livid or black discolouration, the ordinary appearance of *bruise*, as seen in the first instance, accompanied with more or less swelling; presenting the characters of the "black eye" produced by a blow. If only a small quantity of blood be extravasated, the appearance is designated *ecchymosis*. The pain of contusion is of a dull, heavy, aching character; or a vibrating sensation, extending perhaps far beyond the part, when a large nerve is more especially affected; as

the ulnar nerve at the elbow. Blood extravasated in considerable quantity may still present the appearance of bruise, but have also the fluid and fluctuating character of an abscess. A hard *circumscribed* boundary can also perhaps be felt. Puncture with a grooved needle will determine a doubtful diagnosis. The discolouration of contusion bears a general resemblance to gangrene, but the temperature and sensibility of the part are retained, at least in a higher degree than in that condition. When extravasation of blood has taken place, deeply, and possibly into internal organs, it is declared by *functional disturbances* of a less definite character, and which of course vary with the part to which the contusion extends. Compression of the brain, for example, may arise from cerebral contusion and extravasation.

Causes of Contusion.—External force, in the shape of crushing pressure or a blow, may *directly* produce contusion; or the force may be applied *indirectly*, at some distance from the part affected, as by a fall on the feet, bruising the legs. But the state of the textures very much *predisposes* to this kind of lesion. The elastic firmness and comparatively bloodless condition of the flesh of a prize-fighter, who has undergone "training," contrasts favourably with the flabby, bloated face of one who is "out of condition," as that of the intemperate debauchee, which is ever bordering on ecchymosis.

Concussion often accompanies contusion; parts distant being shaken, as well as the part at the immediate seat of injury being crushed, by the violence of the force applied. Hence, concussion is more often produced in contusion from indirect violence. Thus, the minute vessels may be concussed or shaken far beyond the range to which actual contusion extends. A fall from a height on the feet, causing contusion, may be attended also with concussion of the vessels, even up to the trunk; as denoted by interstitial spots of extravasated blood, in a case recorded by Sir B. Brodie. Concussion of the nerves, apart from actual contusion, is also an important distinction, which Billroth notices, in relation to parts distant from the immediate seat of injury. For example, dangerous symptoms may be produced simply by concussion of the cardiac and pulmonary plexuses of nerves, in connection with contusion of the thorax. And reflex actions of the concussed nerves may possibly have their additional effects; as witnessed in the syncope or faintness induced by a blow on the epigastric region of the abdomen. The consequences of concussion, rather than contusion, affecting the nerves, are uncertain; resulting in various forms of paralysis, both motor and sensory, with atrophy and degeneration of the muscles involved.

The operation of contusion *locally* is identified with the course of this lesion; while its effects *constitutionally* are those which arise from other forms of Injury, and Hæmorrhage; but the syncope arising from contusion is due more to the injury, itself possibly extensive and severe, than to the extravasation of blood. Therefore, the shock of injury, as manifested by the nervous system, predominates, rather than collapse; or tetanus may supervene.

Course.—The natural course of Contusion is twofold; inclining, on the one hand, to *subcutaneous reparation;* on the other, to *sloughing*, the formation of an open wound, and repair by the process of suppurative granulation. Thus, no perceptible alteration may take place in a contused part, the bruised appearance remaining for a variable period;

but absorption supervenes, and the originally purple or livid discoloration of a bruise gradually fades away into a brown, and thence into a greenish or yellowish hue, the latter often continuing for weeks or months. Blood extravasated in considerable quantity may also remain stationary for a while, as a bag of fluid. Over prominent parts, as the crest of the ilium and the great trochanter, I have seen large tumours of this kind produced by heavy falls. Generally, however, any such collection of blood undergoes changes of consistence; becoming thin and serous, and enclosed in a fibrous cyst; or thick and dark like treacle, constituting a sanguineous tumour—hæmatoma; or with coagulation, organization of the clot may result, by the development of new blood-vessels. In either of these reparative alterations, the blood corpuscles disintegrate to some extent; and hence, apparently, the changes of colour, followed by absorption; and it can scarcely be doubted that the damaged structural condition of the textures is more or less reinstated. But the intimate nature of all these reparative alterations, after contusion, requires further investigation. Lastly, the most obvious change may be destruction, prevailing over any reparative effort; the blood, acting as a foreign body, induces inflammation, the products of which, commingling, form a bloody purulent fluid, extravasated amid the disintegrated textures. Gangrene is imminent, an event the more apt to ensue according to the severity and extent of contusion; and gangrenous disintegration of the textures may appear in the form of sloughing, or as traumatic gangrene, thus converting the subcutaneous lesion into an open lacerated wound. Sometimes, the extravasated blood rapidly passes into decomposition, accompanied with the symptoms of pyæmic infection. Hæmorrhage, superadded to the blood originally extravasated, is another adverse issue, but even less common, unless in internal organs.

Reparation by the process of suppurative granulation will be described in tracing the course of a contused or lacerated wound.

Treatment.—The *earliest occasion* for interference is determined, not by the presence of contusion, which is naturally disposed to undergo reparation; but it depends on the degree of contusion and the quantity of blood extravasated. A slight ecchymosis disappears spontaneously; a more severe bruise may need help.

The *indications* are, in the first instance, to stop any further extravasation, and then to promote *absorption*, without any breach of the integument. Compression, by the application of a bandage, may perhaps, therefore, have a doubly good effect. Various topical applications have reputed efficacy. Arnica, I think, possesses some virtue. The tincture diluted, in the proportion of an ounce to half a pint of water, is perhaps more efficacious than spirit lotion, or any other cold evaporating fluid. Leeches are not merely useless to withdraw the blood, congealed and infiltrated; but by admitting air, and thus inducing decomposition, they are positively noxious. Moreover, they are apt to excite sloughing of the skin. When the blood is in a fluid state, it may be drawn off by means of the aspirator; but the cavity is apt to refill again and again; as in a case of extensive contusion of the back, from which I thus removed ten to fifteen ounces of sanguineous fluid several times. Should suppuration or gangrene threaten,—whether from the blood acting as a foreign body, from the severity and extent of the contusion, or from both these conditions co-operating,—then,

indeed, *incisions*, early and free, are imperative, to give vent to blood and pus, which would otherwise rapidly putrify, and to prevent sloughing, or its progress. In short, any attempt to aid absorption would now be inappropriate, and the rule of treatment should be to anticipate if possible, or at least accompany, the work of destruction, and forthwith remove its results. Accordingly, in the event of traumatic gangrene, amputation may become justifiable, as an extreme and rare resource.

CONTUSED and LACERATED WOUNDS.—*Structural Condition.*—These forms of Injury, although nominally distinct, in regard to the kind of force by which they are produced, are essentially the same. A contused or a lacerated Wound is a sudden disintegration of the *soft* textures, with *exposure* to the action of the air. In the latter respect, wounds of this kind differ from contusion—a subcutaneous lesion; and in virtue of the former particular, they differ from compound fracture and compound dislocation, wherein the lesion itself is not exclusively laceration of the soft textures, these parts being involved only by the injury.

The *characters* of a lacerated wound are peculiar. It presents a torn, irregular surface or cavity, with more or less surrounding swelling and discolouration, owing to effusion of blood beneath the skin, or ecchymosis. Hæmorrhage from the wound itself is inconsiderable, the vessels being lacerated. With these external appearances, the degree of pain experienced would seem to be inversely proportionate to the extent and depth of the laceration; for this kind of injury implies a corresponding destruction and death of the textures. The pain is heavy and aching. The structural alterations produced by laceration, and thence the characters of a lacerated wound, are somewhat modified by the extensibility, elasticity, contractility, and other properties of the textures. The resulting appearances are most conspicuous when a limb is drawn off, as by machinery; or abruptly struck off, as by gun-shot injury. Some textures are comparatively unyielding, and their torn extremities hang out of the stump; others break off short within the general mass. Thus, the skin being tough and elastic, it either yields higher than the included textures, or it retracts, exposing them; the muscles protrude and are everted; the tendons resisting with greater tenacity, they hang out of the stump, or giving way higher up, they are pulled out of their sheaths; nerves, for the most part, break off at the surface; the vessels, especially arteries, possessing considerable elasticity, are drawn out to some length, their inner and middle coats yielding, while the external coat is prolonged over them; and as their torn ends retract, they become less pendent and exposed than any other part of the stump; lastly, the bone having broken off abruptly, it forms the most prominent point. The stump, therefore, presents an irregular conical form, with the truncated bone as its apex.

Causes of Lacerated Wound.—The force applied may be chiefly lacerating, as when a leg is crushed by a railway carriage passing over the limb, or an arm is torn between two revolving cog-wheels; or the violence may be chiefly contusing, as the kick of a horse, or the action of a cannon-ball or other projectile. In either case the part is damaged beyond, and perhaps far beyond, the apparent extent of injury.

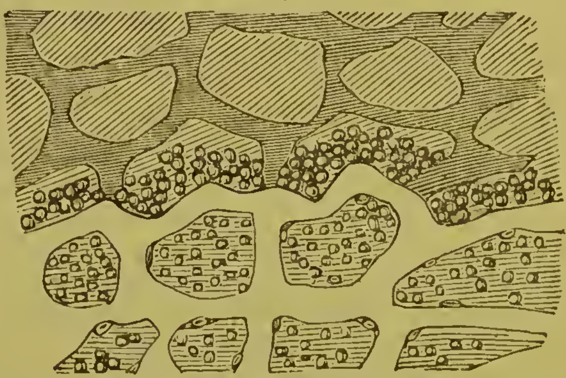
The *constitutional* effects of the contused or lacerated wound are those already noticed with reference to other forms of Injury, and

Hæmorrhage; but the syncope arising from such lesion is due more to the injury, itself possibly extensive and severe, than to the extravasation of blood. The shock of injury is always severe, sometimes overwhelming; tetanus also is apt to supervene, especially after any such wound of the hand or thumb, of the sole of the foot or of the toes.

Locally—the textures, disintegrated by violence, inevitably die to a greater or less extent. This event, which is strictly speaking *traumatic* gangrene, on however small a scale, takes place in one of two ways, or both may co-operate. Severe contusion or laceration kills the part outright; or it does so indirectly, by damaging the blood-vessels some distance off, in which case mortification is occasioned by a deficient supply of blood to the part. In both cases, gangrene is *immediate*, or at least immediately commences; it evinces *no* tendency to *spread* beyond the seat of injury, and, in due time, is *defined* by sloughing, or by "a line of demarcation" when the injury is more extensive.

The appearances and textural changes may be gathered from Billroth's observations. Completely crushed skin presents a dark-blue violet appearance, and feels cold; or, at first there may be no alteration, but in a few days it becomes white and insensible, later it assumes a grayish hue, or when quite dry, a brownish-black colour. The healthy skin is bordered by a rose-red line, which shades off into diffuse redness; this is the reaction redness about the wound, marking the line of the living skin, which only begins where the blood still flows through the capillary vessels. In muscles, fasciæ, and tendons, this appearance is far less pronounced at first; and how far they will be detached is uncertain. The process of separation comprises the following textural changes:—At the line of junction of the dead with the living tissue, the circulation is arrested by coagulation of the blood in the adjoining capillaries, and nutrition ceases; cell-infiltration and the formation of vascular loops lead to the development of granulation tissue, from the surface of the living tissue below; and then, by the solution of the granulation tissue into pus, its cohesion and continuity with the dead tissue ceases, and the parts are detached. (Fig. 96.) This suppurative separation in connective tissue takes place in all other tissues, bone not excepted.

Fig. 96.*



But more often the gangrene of a contused wound is of an inflammatory character, and occurs at a somewhat later period—in the course of a few days—as follows:—

Course.—Gangrenous inflammation supervening, in the progress of

* Diagram of the process of detachment of dead connective tissue in a contused wound. Upper, or contused, dead portion, showing blood-vessels occluded by coagulation; lower portion, the living tissue, is the seat of cell-infiltration, principally at the junction of the living with the dead tissue. 300 diam. (Billroth.)

a contused wound, the textures or a part which may not have been killed more immediately by the injury, die subsequently. Yet here, also, the gangrene is limited to the seat of injury, and is defined by sloughing. Gangrene may, indeed, supervene on a contused or lacerated wound, without any apparent or notable inflammation, and extend far beyond the seat of injury; a whole limb speedily falling into gangrene, which spreads rapidly and is not determined by a line of demarcation. This, which has been named *spreading* traumatic gangrene, is traumatic only in having arisen from injury as the immediate or exciting cause; but its spreading and unlimited character points to some blood-condition, in operation, as the essential cause. In fact, this gangrene is the local manifestation of a constitutional condition, rather than the consequence of a local cause in operation. Its pathological significance is corroborated by two facts—that the contusion or laceration is quite subordinate in extent to the supervening gangrene; and that it occurs in those persons especially who have albuminuria, a state of urine indicative of the retention of excrementitious matters, chiefly urea, in the blood.

Either form of gangrene—traumatic or inflammatory—is always humid or moist, unlike the dry species of which senile gangrene is the representative. When a part is killed immediately, the appearances are those of the most severe contusion or bruise; when less immediately completed, as by injury to the blood-vessels, the symptoms are the same, but proportionately more gradual; and when gangrenous inflammation supervenes, the symptoms are those of inflammation rapidly passing into gangrene. But when spreading traumatic gangrene takes place, the phenomena are those of a severely poisoned wound. Gangrene is announced by great tension and livid or purplish-black discolouration, which although most conspicious about the seat of injury, extends rapidly upwards and downwards; its progress being preceded by a slighter œdematous swelling and greenish-yellow discolouration. This in advance, is a dying part; that in the rear, is already dead. Emphysematous crackling, under pressure with the finger, soon leaves no doubt that death and decomposition go hand in hand. The accompanying constitutional symptoms are those of typhoid blood-poisoning; and the disease generally terminates fatally in a very few days, or not later than whenever the gangrene shall have spread to the trunk.

Reparation.—In favourable contrast with any tendency to death, the wound may evince a disposition to heal by primary adhesion; or, any irrecoverable part having sloughed and separated, the exposed surface heals by *suppurative granulation.* But the process of reparation is best seen on the clean surface of an open or gaping incised wound. This process is then as follows:—The local circulation is temporarily suspended, and the blood in the superficial vessels becomes stagnant, and coagulated up to the nearest branches. Any oozing hæmorrhage is thus stopped. During the first day or two, a reddish-yellow serous fluid exudes from the surface of the wound, which, containing pale blood-cells and a fibrinous matter, sets into a thin, yellowish-white or greyish film, rendering the appearances of the subjacent tissues indistinct. Thus the whole surface becomes glazed over. Symptoms of inflammation may, perhaps, precede and accompany this exudation; some redness, puffy swelling, heat and tenderness, just around the

margins of the wound. But, in a healthy state, this inflammatory character passes off. A period of *inactivity* or calm succeeds, lasting from one day to ten or more, but which varies with each particular texture in the wound; fat being tardy in its revival, as compared with the more vascular skin, or muscular texture, and bone, especially the compact portion, remaining longest dormant. Some further oozing of the serous fluid may, however, continue during this period of incubation,—in which, as the brooding time for good or evil, observes Sir James Paget, the mode of healing will be determined, and the mutual influence of the injury and the patient's constitution are often manifested. At length, a distinct afflux of blood takes place, but with sluggish circulation, in the margins and surface of the wound. *Reparative* lymph begins to flow, abounding with emigrated white blood-cells, which mingles with or displaces the film which had hitherto glazed the wound. This lymph undergoes the same process of organization as in healing by primary adhesion, namely, self-development into fibro-cellular tissue; but in the form of granulations. Numerous minute bright-red points, or nodules, spring up from the surface of the wound, as seen on an open amputation stump; appearing first on the margin of the skin and the general muscular surface, while the bone-end or its compact disc remains yet covered only with the yellowish-white lymph-film. These rosy nodules or granules are young granulations. The deepest granulation-cells are most advanced; they are spindle-shaped, or elongated nearly into fibres. (Fig. 97. Bennett). The

Fig. 97.

superficial ones remain in a rudimental state, and at length acquire the character of epithelial cells. Capillary blood-vessels spring from below, forming loops—as also seen in the figure. Each new vessel is constructed by he outgrowth of two pouches from a parent vessel. The pouches, crammed with blood-corpuscles, shoot upwards, and curving inwards, never fail to meet exactly in apposition, neither segment overshooting. They coalesce by absorption of the partition at the junction of their closed ends, thus completing a vascular loop; through which the blood, diverging from the main current and rejoining it, is continuously propelled. If, in the construction of any such vascular arch, the pouches burst, the process is then completed by the propulsion of the blood-corpuscles, the current of blood from the parent vessel being directed

so skilfully as to channel a curved passage through the fibro-cellular tissue. Nerves and lymphatics do not apparently enter the substance of granulations.

The process of development having finished, healthy granulations are seen in the shape of small conical papillæ, of a glistening red colour when free from pus. The *pus-cells* in suppurative granulations are either degenerate or immature granulation-cells. If the former, pus represents the *superficial* portion of organized granulation material, which, having lived its time, passes off, just as epithelial cells are detached. If immature granulation-cells, pus represents the *superfluous* portion of organizable material, which never reaches maturity. This is the more probable interpretation, considering the structural similarity or identity of pus-cells. As *immature* granulation-cells, pus ceases to be secreted when the granulations come to the level of the skin, for then, the wound or chasm being filled up, no more organizable material is needed.

Sometimes during the granulating process, granulations from opposed surfaces meet together. They may then unite; this conjunction being designated "secondary" adhesion, to distinguish it from adhesion primarily, as between the surfaces of an incised wound. But it takes place in the same way, by the development of fibres out of nucleated cells and the interchange of capillary blood-vessels through this medium of commuication. The contractile force of granulations is supplemental to reparation in bringing down the marginal skin to their own level and diminishing the area of the wound. Thus, then, by their actual growth and possible coalescence, aided by their contraction, granulations and skin at length become even.

Cicatrization commences, its purpose being to cover the granulations with skin. At the margin of the wound or ulcer, the granulations become flattened, and cease to secrete pus; appearing as a red, dry, smooth border, about half a line in breadth; this is followed by a translucent, bluish-white border, in advance of the opaque-white true skin. Converging at the rate of about half a line daily, the surface gradually gets covered. Sometimes little islands of cuticle form, here and there, on the granulation surface, which coalesce, and thus shorten the process of marginal cicatrization. But these isolated centres or patches of epidermis appear only where corresponding portions of the cutis with rete malpighii have remained undestroyed, on the surface of the wound or sore. (Billroth.) Newly formed and healthy *cicatrix* is thin and red, with a stretched, shining aspect, and not so supple and elastic as true skin; somewhat depressed, sometimes elevated, but always attached more or less firmly to the subjacent tissue. It contracts for a long while, and perhaps with considerable force, especially after burns, thus becoming smaller in area, particularly if the surrounding skin be loose or redundant. In the course of months or years, the cicatrix acquires a pearly white colour, and becomes more supple, elastic, and movable as part of the integument. Nature has healed, and almost effaced the wound. But a cicatrix always remains permanently, being more or less visible for life; it never wears out altogether. It is less vascular, and less sensitive than the adjoining skin. Resembling true skin in its fibro-cellular structure, cicatrix never acquires its glandular elements, neither in the form of sweat glands or sebaceous follicles; and it remains destitute of hairs.

Accidental complications—both local and constitutional—may occur in the course of a contused or lacerated wound. *Secondary* hæmorrhage is apt to happen when the sloughs or gangrenous portion separate; and when, occasionally, a large-sized artery is thus laid open, in about a week or ten days, or from the suppuration of a thrombus or fibrinous plug, at a later period, the loss of blood may be of serious consequence. Bleeding granulations sometimes prove troublesome.

Progressive suppuration may take place from a contused or lacerated wound; the pus undermining the integument, extending along the sheaths of tendons, and burrowing deeply between the muscles. The part becomes swollen and sodden, and the granulations pale and œdematous; the pus also has a sanious, fœtid character, and is exuded through fistulous openings. This state of the part is more often met with when the hand or foot, or a large joint, was the starting-point of the suppuration, in a lacerated wound of either such part. The constitutional condition is no longer that of traumatic febrile disturbance, as in connection with the original wound, nor of the typhoidal character with gangrene, nor the collapse from secondary hæmorrhage; but hectic emaciation ensues, and exhaustion.

Various *secondary inflammations* may proceed from a contused or lacerated wound. Lymphatitis, phlebitis, erysipelatous inflammation, and sometimes hospital gangrene, thus arising, offer no special peculiarities of practical importance. Ichorrhæmia or pyæmic infection may also be noticed as occasional consequences.

The *Prognosis* of Contused and Lacerated Wounds may be gathered, as with regard to other injuries, from a due consideration of their nature and course. It is less favourable than that of an Incised Wound, owing to the kind of structural *disorganization* in contusion or laceration. For gangrenous disintegration of the textures, in a greater or less degree, is inevitable; or gangrenous inflammation, with sloughing and suppuration. The *extent* of the lesion will, therefore, much affect the issue. *Spreading* gangrene is an adventitious condition, but it is the most unfavourable consequence of contusion or laceration, as implying the co-operation of a *constitutional* cause. Healing by primary adhesion is exchanged for the slower and perhaps less effectual process of suppurative granulation; yet the latter being another mode of Reparation, it must be regarded as an *eventually favourable* element in the prognosis of the lesion under consideration.

Treatment.—In all *superficial* wounds—contused or lacerated—and especially of vascular parts, as the scalp, the chance of primary adhesion taking place, to some extent, is not improbable, and it may be solicited with good prospect of success. In the first instance, therefore, the treatment should be the same as for an incised wound. Foreign bodies, such as grit or portions of clothing, having been removed by a wet sponge or stream of water, replacement of the torn textures, and their retention in position by the usual surgical appliances, are the immediate rules of treatment to be observed. The prevention of decomposition is a consideration of primary consequence, both with regard to healing of the damaged textures, and to any liability of systemic infection. Accordingly, an important principle of treatment consists in the exclusion of air, and the continued application of cold. This may be carried out in various ways; by immersion of the part in cold water, by irrigation, or by wrapping the part in lint, and applying an ice-bag. These pre-

ventive measures have been practised chiefly in Germany; Professor Baum, of Göttingen, having used the bath, and with excellent effect in some cases, while Professor Billroth often employs it, though he does not regard this or the other such methods as surely prophylactic of decomposition. In France, irrigation is especially approved by some surgeons. I have also used it with complete success; particularly in the case of a smashed hand, which seemed hopelessly lost. The temperature of the water-bath should be moderated according to the feelings of the patient; and this mode of treatment may be continued for a week or ten days, the part being cleansed from pus, which does not itself freely escape, and the water being changed so as to keep it quite fresh. If the cuticle of the part be thick and unyielding, as in the hand of a labourer, any continued soddening will, perhaps, be attended with a tense, burning sensation, quite unendurable. Lubrication with oil, or the addition of a handful of salt to the water, is said to afford protection against this contingency. The healing by granulation is slower in a wound under water and the influence of cold; but when the treatment is discontinued, in time, the pale and infiltrated granulations, œdematous with the water, become ruddy and firm, and the wound soon begins to contract and cicatrize. Generally, however, carbolic acid dressings and syringing seem to have the advantage over cold water treatment, in being equally protective against atmospheric influence, without further endangering the vitality of the already disorganized part, by the prolonged application of cold. But the disintegrated textures inevitably die, to a greater or less extent. Hence, in the event of primary adhesion having failed entirely, and in all *deep* and *extensively* contused wounds, it becomes necessary to actually encourage and aid the process of sloughing, in order to bring into operation that of healing by granulation. The separation of sloughs will be favoured by warmth and moisture, in the shape of a light poultice or spongio-piline epithem. At this time secondary hæmorrhage is liable to occur, if an artery of any considerable size was involved in the contusion or laceration. Any collection of matter should be let out, or a free vent may be given by a counter-opening, and discharge facilitated by the temporary introduction of a drainage-tube. Otherwise the reparative process needs little assistance; position, rest, and protection from the action of the air by carbolic acid dressing, will suffice for the granulating of any healthy wound.

Deep and *extensively* contused or lacerated wounds of either *limb* are conditions which, in relation to profuse suppuration or gangrene, must be considered both with regard to the preservation of the limb and the life.

Amputation.—The propriety of amputation has regard to both these issues, which will be more advantageously considered in connection with *compound* fracture and dislocation. If gangrene be allowed to *supervene*, *life* is endangered; if the *limb* be removed *before* the supervention of gangrene, it may have been sacrificed by such untimely interference.

The compromise of these two considerations is better determined by pathology than by empirical experience:—

(1.) If the *whole substance* of a limb be involved by the injury, gangrene is inevitable; amputation, therefore, is imperative to intercept this event, and thus preserve *life*. (2.) If, however, the injury be less

extensive, and gangrene not inevitable; what then? Various pathologico-anatomical conditions—*less* than the whole substance of a limb being involved—are defined in surgical works; respecting which forms of injury experience is said to justify amputation, in the first instance, considering the probable supervention of gangrene. But this event can never be foretold with absolute certainty in different conditions of injury; the resources of reparation and the reserve constitutional power of different individuals being *unknown.* Having regard, therefore, to the preservation of the *limb*—in cases short of its irreparable destruction—the *actual supervention* of gangrene is the only ground of assurance as to the urgent necessity for amputation.

This compromise between limb and life may be thus stated:—whenever a limb is destroyed, by injury, and life would be perilled by the inevitable supervention of gangrene, (primary) amputation is imperative; whenever a limb is not entirely destroyed, the *rule* should be, to give the limb *its* chance of recovery, by waiting for gangrene; but in that event (secondary) amputation becomes necessary, and further delay would peril life, without the compensating probability or possibility of preserving the limb. Duly weighing both these conditions, the Surgeon will ever be prepared to estimate the urgency of amputation in any particular form of contused or lacerated wound—otherwise than when destructive of the whole substance of a limb.

The *time* also, as well as the conditions, for the performance of amputation is a very important consideration. Amputation for injury, in general, is commonly divided into Primary and Secondary; the *primary* being that which is performed during the first twenty-four or thirty-six hours,—before inflammation has commenced; the *secondary* being amputation performed after that period,—after the supervention of inflammation, and, at a later period, suppuration. Amputations performed in the intervening period, between twenty-four hours and inflammation, are sometimes designated *intermediate.* With regard to contused and lacerated wounds, the proper *time* for amputation under different circumstances, as expressed by the terms primary and secondary, has reference to the performance of the operation before or after the occurrence of gangrene; in accordance with the rules already laid down.

Part for Amputation.—In the event of *gangrene*, the *seat* of amputation, or the portion of limb to be removed, should not be determined by waiting for the formation of the line of demarcation between the living and dead parts. Amputation must be performed at once, and sufficiently high above the seat of injury to prevent the recurrence of gangrene in the stump. The foregoing considerations relate exclusively to purely traumatic gangrene. *Spreading* traumatic gangrene being the local manifestation of some morbid condition of the blood, its supervention is so far less likely to be intercepted by the primary amputation of the injured part. On the other hand, gangrene appearing in the stump, would frustrate the intention of the operation with regard to the preservation of life. When spreading gangrene has supervened, the Surgeon is placed in this dilemma in regard to the part for amputation:—if the operation be performed without waiting for the line of demarcation, gangrene will probably reappear in the stump, and death ensue; if the operation be postponed, for this purpose, the gangrene spreads rapidly up to the trunk, and then death is

inevitable. Considering that the injury is the exciting cause of this gangrene, amputation had better be performed at once, and at some height above the apparent seat of injury. But, in selecting a sound part of the limb, and not merely that which may recover itself as a stump, it must ever be remembered, that while the damage done by contusion or laceration is more extensive than may appear on the surface, the destruction wrought by spreading gangrene, especially in the cellular texture, has even a wider range up the limb, than as declared by any discolouration of the skin. The safest parts for amputation are, probably, at the shoulder-joint, when the arm is involved; and in the upper third of the thigh, when the leg is affected as far as the knee.

The *after* or *constitutional* treatment is fully considered in connection with the *general* pathology of Gangrene.

PUNCTURED WOUNDS.—*Structural Condition.*—A Punctured Wound is a more or less contused and lacerated wound; varying in *depth*, but of greater extent in this direction than superficially. Structures may thus be injured far beyond what appears to be the extent of injury, by the aperture in the integuments. Other kinds of Wound—the incised and the purely contused or lacerated—may indeed be *complicated* by their depth; a punctured wound is characterized by this additional element. Thus, penetration of an artery and the formation of traumatic aneurism may complicate a punctured wound in any part. Penetration of the brain complicates a punctured wound of the skull; and similar injury of the lung or heart, or of one or more of the abdominal viscera, may complicate a punctured wound of the thoracic or abdominal cavities respectively.

The *external characters* of a punctured wound are comparatively unimportant, and not characteristic. Varying in size, from a pin's point to a bayonet-thrust or an aperture of larger size, its shape differs with the form of the penetrating instrument; the margin of the aperture is irregular and the surrounding integument bruised, if the wound was produced by the penetration of a blunt-pointed instrument; and this laceration and contusion are the more conspicuous if the weapon was of increasing size from the point upwards, as a bayonet. The hæmorrhage cannot be estimated by the quantity of blood which escapes externally. The narrow track of a punctured wound and laceration of the textures, rather impede the escape of blood, and are favourable to the formation of traumatic aneurism. If the wound extend into an internal cavity, as the thorax, hæmorrhage may take place yet more abundantly without a corresponding escape of blood from the aperture externally.

The Symptoms connected with the penetration of *particular parts*, perchance the viscera, are specially significant, in virtue of the function of the part which is thus involved; but, as not pertaining to the general pathology of Punctured Wound, such symptoms are here omitted. Each successive injury, in depth, is less open to detection, owing to the narrow track of the wound. The *diagnosis*, therefore, must be determined by *functional* symptoms; and it will be remembered that structures of vital importance, possibly, may be implicated, beyond the otherwise apparently simple puncture, viewed externally.

Causes, and Effects of Punctured Wound.—Any pointed instrument, sharp or blunt-pointed—*e.g.*, a pin or needle, a thorn or splinter of wood, an old rusty nail, a pen-knife, or a bayonet—represents the

whole class of causative agents. Contusion and laceration are proportionate to the bluntness of the penetrating instrument. The *constitutional* effect of a punctured wound consists, partly, of syncope due to hæmorrhage; partly and perhaps principally, of shock to the nervous system; and here, again, both are generally disproportionate to the apparent importance of the local lesion, which by its depth may involve large blood-vessels and nerves, and possibly implicate a vital organ. Tetanus is another constitutional condition not unlikely to occur.

Course.—Sloughing ensues, more or less in extent, along the track of the wound, accompanied with suppurative discharge; but eventually it heals by granulation. If the textures are not much contused nor lacerated, the wound may heal by primary adhesion; and this, although the depth of penetration may have been considerable, extending even into a great cavity and involving an important organ. Thus, in one case under my observation, after a stab in the back with a fork, which entered the lung, union of the flesh-wound speedily ensued, and the lung-symptoms also subsided. In another case, after a similar stab in the loins, penetrating the kidney, this mode of healing occurred, and the hæmaturia disappeared. Apart from this general vital history, a punctured wound extending into any internal organ, exhibits a series of phenomena peculiar to the particular organ implicated; and thence the completion of the vital history of this form of injury, as occurring in different parts of the body, belongs to Special Pathology.

Prognosis.—The prognosis of Punctured Wound is partly analogous to that of any other contused or lacerated wound. It is unfavourable in so far as the kind of structural *disorganization* is that of contusion or laceration. Sloughing and suppuration to some extent are almost inevitable. The presence of any *foreign body* in the wound has a similar influence. But the prognosis is specially unfavourable according to the *depth* of the wound—or the number and functional importance of the parts implicated, as complications of the wound. Injury to large blood-vessels, nerves, or an internal organ, are thus, severally, unfavourable conditions; and according to the importance of the functional disturbances thence arising.

The subsequent course of a punctured wound, in its undergoing reparation by suppurative granulation, is an *eventually favourable* ground of prognosis.

Treatment.—The first indication is to arrest hæmorrhage, which obviously claims immediate attention when it occurs in any considerable quantity. Pressure, by means of a compress, will generally prove sufficient, unless a large artery be punctured, when it will be necessary to ligature the vessel above and below the aperture, by cutting down in the track of the wound, if it can possibly be thus secured. The removal of any foreign body is another obvious indication, whenever it can be safely fulfilled. A portion of clothing may have been thrust so deeply into the wound, and possibly into some internal organ, that its presence cannot be ascertained with certainty, nor its removal effected with safety, and without unwarrantable mutilation.

Guided by the processes of reparation, healing by primary adhesion should be *attempted* in all cases; but the prospect of success will depend on the comparatively simple character of the wound, by the less circumferential contusion, the absence or removal of any foreign body,

and the arrest of hæmorrhage. Failing in most cases to induce adhesion, the process of suppurative granulation is the alternative to be solicited, as in the usual treatment of a contused or lacerated wound.

A *needle*-punctured wound, although trivial in itself, is apt to present some difficulty in the extraction of the foreign body; the needle being driven in entirely, or having broken off, leaving a portion embedded. This complication may be increased by the locality of the needle; when near to large vessels and nerves, as in the axilla, and movable in cellular texture; or impacted in a large joint, as the knee; or thrust into or under the sheaths of tendons, as in the fingers and toes. I have experienced more or less difficulty in removing a needle from either of these situations. The point, or the end of the broken portion, may perhaps be near the puncture-wound, and it can sometimes be detected by the pain produced on slight pressure over the spot, or a pointed projection under the integument may be felt; but the needle easily shifts its position, and thus evades seizure with a fine pair of forceps. Careful dissection, with light sponging, will at length expose a black point, which when seized with the forceps is found to be metallic, and then the foreign body is readily extracted. Needles which have been swallowed, migrate through the coats of the stomach or intestine, and work their way into all parts of the body, at last perchance coming to the surface in some quite unsuspected situation. Under any circumstances of doubt, if a needle be impacted, or have come to the surface, its presence may be declared by the magnetic method, devised by Mr. John Marshall; the suspected part is brought under the influence of a powerful magnet for a quarter of an hour, then, on suspending over it a polarized needle, some deflection would indicate the presence of iron.

CHAPTER XVIII.

GUNSHOT WOUNDS.

Gunshot Wounds.—*Structural Condition.*—Of Complicated Injuries, none are more interesting and important than Gunshot Wounds. But they chiefly concern the Military Surgeon, although the general Surgeon is occasionally called upon to undertake the charge of such injuries in civil practice. It will, therefore, be doubly necessary to fully consider the guiding elements of their pathology and treatment.

Gunshot wound is, essentially, a contused and lacerated wound; but varying in *extent* and *depth.* The latter element is always a critical consideration. Other kinds of wound—the incised, and the purely contused or lacerated—may, indeed, be thus *complicated;* but a gunshot wound is usually characterized by one or other of these additional elements. Structures may thus be injured far beyond what appears to be the extent of injury, in connection with the aperture or apertures in the integuments. If any part, as a limb, be shot away entirely, as by a cannon-ball, the extent of injury is more openly declared. Thus,

also, penetration of an artery, with the formation of traumatic aneurism, may complicate a gunshot wound in any part. Penetration of the brain complicates a gunshot wound of the skull; and similar injury of the lung or heart, or of one or more of the abdominal viscera, complicates a gunshot wound of the thoracic or abdominal cavities in either such case. Compound Fracture or Compound Dislocation not unfrequently complicate the more severe forms of gunshot injury.

The *course* of a ball in the body is determined by its shape and velocity. The round musket-ball — formerly in use and propelled with a velocity which scarcely reached eighty yards, revolving, also, on its axis, at right-angles to its transit—was turned aside by the slightest obstacle. On striking the body, the resistance offered by clothing, or, on penetrating the skin, by a bone, and, indeed, the different resisting media of different structures, would deflect the ball from its course, and make it assume a circuitous and perchance most extraordinary route; ultimately lodging in the body in many cases. Now-a-days, the cylindro-conoidal rifle-bullet, generally used, and propelled with a velocity true at 1000 yards or more, pursues its course straight through the body, and out again, in most cases. An apparent deviation is sometimes due to the Surgeon omitting to view the patient in the position he was when the ball entered; and occasionally, though rarely, a real deviation, possibly a circuitous course, is caused by an accidental concurrence of circumstances, especially when the velocity of a conoidal bullet has become diminished.

Of the various *textures*, none suffer so much damage as bone by the penetration of a conoidal bullet. Piercing and passing through the soft parts, it splits and comminutes any bone in its way, producing fissures which extend into neighbouring joints; the greater destructiveness of this shaped projectile resulting from its wedge-like action, and the peculiar resistance offered by the osseous texture. The bullet itself becomes somewhat changed in shape; its apex being flattened and reverted, if it strikes point-blank; or planed from its apex towards its base, when it strikes parallel to its line of flight.

Foreign bodies, of various kinds, are often lodged in a gunshot wound, and not unfrequently lie deeply buried; thus constituting another complication.

The *lodgment* of any foreign body is determined by its shape and velocity, chiefly by the latter circumstance. A conoidal ball, with a considerably reduced speed before entering the body, will lodge, more or less deeply; while a round ball, although at full speed, having taken a circuitous route in the body, may become expended, and thus effect a lodgment. Bullets scattered from canister or spherical case, are liable to lodge; owing apparently to disturbance of their course in the primary discharge, and secondarily, by explosion of their containing case. Grape-shot lodge occasionally, and possibly after a very devious course in the body. More rarely, a cannon-ball lodges, and remains concealed. A ball weighing 8 lbs. was buried in the thigh, and discovered only by amputation. (Guthrie.) In another case, a ball weighing 5 lbs. was found also in the thigh by amputation. (Larrey.) Penetrating fragments of shell, if projected edgeways, almost invariably lodge, and are frequently concealed; of which some remarkable instances are mentioned by Mr. Longmore.

In exceptional cases, a *small scale* may be detached from a leaden

bullet, and this lodges in the wound. Such portions may occur, irrespective of the shape of the bullet, from a cylindro-conical as well as from a round bullet; and instances of either kind came within the experience of the last-named authority during the Crimean war. In gunshot wounds of the skull, a ball impinging obliquely is especially liable to be split; one fragment penetrating the cranial cavity, and the other lodging under the scalp, or flying off. Cases of this kind are mentioned by Larry, Hennen, and Guthrie; and some half-dozen instances are recorded in that most valuable *repertoire* of American experience, "The Medical and Surgical History of the War of the Rebellion," by Assistant-Surgeon George A. Otis, under the direction of the Surgeon-General, Joseph K. Barnes. 1870. (Part I. vol. ii.)

Other *kinds* of foreign bodies, and of various shape, as gravel, bits of wood, portions of clothing, etc., are not unfrequently found, or remain deep in a gunshot wound; any such substance being additional to the projectile, or the only extraneous substance. In the discharge of fire-arms, or of cannon, certain substances are apt to be thrown off accidentally, and may be found imbedded in a wound thus produced; as when a fragment of a copper cap is blown off, or a piece of fuse. Gunpowder is sometimes driven into the skin, as by explosions in blasting or the discharge of blank cartridges; and, in civil practice, similar accidents occur, from the explosion of a powder-flask, or of a gun in the act of loading.

A portion of the body of another individual close at hand, may be struck off by gunshot injury and driven into the one who is the subject of examination. Any such fragment is thus introduced by *indirect* participation in the gunshot injury. A double tooth, belonging to a comrade, was found imbedded in the eyeball, in one case; a portion of the jaw of a companion was driven into the palate in another case; while, in a third case, a piece of the skull was found impacted between the eyelids, the fragment having been shot off the skull of a soldier close by. And, generally speaking, the fragment comes from a corresponding region of the body struck by the shot.

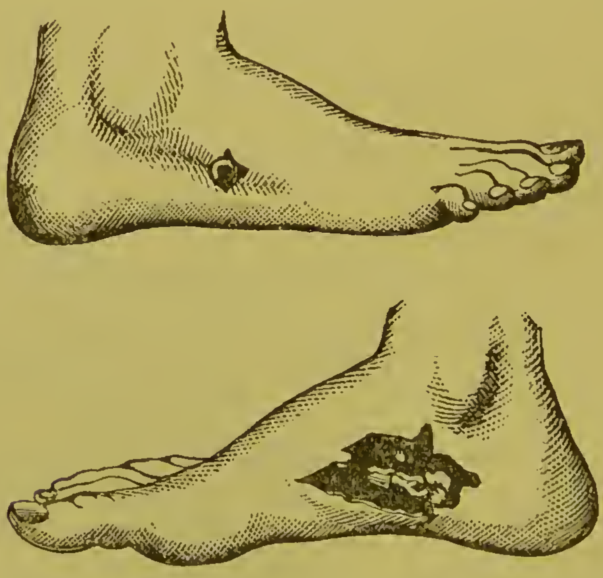
Signs.—The external appearances produced by gunshot wound will depend on the size of the projectile and its velocity.

Number of Apertures.—A small penetrating body, as a bullet, produces—(*a.*) An aperture of *entrance*, and, if the ball lodges, this is the only aperture. But the ball may have passed round and out at this aperture; or it may have rebounded, owing to the elasticity of the part struck, as the cartilages of the ribs; or, having lodged temporarily, it may have been withdrawn in a pouch of clothing. There being only *one* aperture is, therefore, no *sure* sign that the ball has *lodged.* (*b.*) *Two* openings—one of *entrance*, another of *exit*—are produced if the ball penetrates with sufficient velocity to pass through the limb or body. (*c.*) More than one, perhaps *several* openings of *entrance* are produced occasionally. Thus, a bullet having first struck any hard resisting object, and split into pieces, two or more portions may recoil and wound a bystander; producing as many entrance-apertures. In one such instance, a ball split into five pieces by first striking against a rock; and all five portions entered the body of a soldier a few paces off. But the number of openings are not necessarily the same as that of the balls which *penetrate.* For example, of three balls, two may have the same aperture of entrance, and of exit also. This

coincidence happened in the case of a youth who was shot through the abdomen; "that *three* balls went through him was evident, for they afterwards made three holes in the wainscot behind, but two very near each other." (Hunter.) (*d.*) More than one, perhaps *several* openings of *exit* are formed in some cases. Thus, a bullet having struck a ridge of bone and *split* into pieces, two or more portions may pass through; producing as many exit-apertures. In one instance, a ball having split into two pieces by striking against the sharp crest of the right tibia, both portions passed through the calf of that limb, forming two openings of exit, and then each entering the other calf, produced five openings altogether. A portion or portions of a *split* ball may *lodge*. Instances of this kind are recorded, where the ball had struck the edge of the patella, or the spine of the scapula. In like manner, when several *balls*, say three, have entered, one or more may *lodge*. There being an aperture of *exit* is, therefore, no *sure* indication that one or more balls, or a portion of one, has *not* lodged; unless, in the latter case, the entire ball can be found. And, moreover, the *number* of exit-apertures are not necessarily the same as that of the balls which entered, or of the portions into which any one ball may have split. (*e.*) *Several* openings, both of *entrance* and of *exit*, may be produced, and by a *single* ball. In one case, a ball passed through the hand, then the skin of the groin, and next the left buttock; thus causing six openings. In another case, six openings also were caused by a single ball having passed through both thighs and the scrotum. (Guthrie.)

Appearances of the Entrance and Exit Apertures respectively.—They are tolerably distinctive. (Fig. 98.) The aperture of *entrance* is a small, nearly circular opening, or, as produced by a conical ball, it

FIG. 98.



may be linear or crucial, or variously shaped; its margin is inverted, slightly torn, and surrounded with an areola of purple ecchymosis. The aperture of *exit* is larger and more irregular, its margin everted and more lacerated, showing the subcutaneous fat, and with less surrounding ecchymosis. Not unfrequently, there is no actual aperture,

but a reddish discolouration of the integument, the tough and elastic nature of the skin having offered sufficient resistance to prevent the formation of a second opening; in which case, the ball can be felt lying under the skin, at a point about opposite to the entrance-aperture. These differential characters depend chiefly on the diminished velocity of the ball after its passage through the substance of a limb or the body. Consequently, the appearances of the entrance-opening vary somewhat in different cases, chiefly according to the speed of the ball; and its features may resemble those of the exit-aperture. A larger penetrating body than a bullet, and one of an irregular form, as a small piece of shell, produces an opening similar to that of a bullet; but it is more lacerated and less circular, of small size also as compared with the fragment, this peculiarity resulting from the slanting direction in which it penetrates. Generally there is no exit-aperture; such a projectile lodges, owing to its comparatively less momentum. A still larger penetrating body and of an irregular shape, as a larger fragment of shell, produces an aperture yet more lacerated, and of even smaller size as compared with the fragment. It also not unfrequently lodges.

A large-sized projectile, as a *cannon-ball*, may penetrate and pass through the body, producing an entrance and an exit aperture, which resemble those caused by a smaller projectile, as a bullet; only that the characters of either aperture are presented on a much larger scale. If, however, such a projectile as a cannon-ball strikes one of the extremities, it carries away the entire limb, as if transversely amputated; leaving a contused stump, purple and pulpified. The stump is less abruptly truncated and more lacerated, if the ball impinge with diminished velocity, as when bounding along the ground it strikes off a limb. In both these forms of cannon-shot injury, the ball impinges in a direct line. If a cannon-ball strikes the body in a *slanting* direction, thus brushing the surface, and especially if, when moving with a greatly diminished velocity, it rolls over the part; in either case, the skin may not be broken, its elasticity apparently preserving that texture entire, and scarcely any discolouration marks the course of the ball. But the gravest subcutaneous disorganization of other textures is produced; even to the pounding of muscles, vessels, nerves, and bone, or of the viscera. Such internal lesions, unaccompanied by any corresponding external signs, were formerly known as "wind-contusions," and attributed by French authors to the "vent de boulet."

Hæmorrhage of an arterial character may attend a gunshot wound; and sometimes proves fatal almost instantaneously. A gush of arterial blood is seen, and then and there a pallid corpse. Generally, however, the accompanying laceration secures the vessels, as already described (Chapter XVI.), and prevents the escape of any considerable quantity of blood, at the time of injury. The shape of the projectile will modify in some degree the amount of laceration, a sharp-pointed or angular missile cutting rather than tearing the textures; but the velocity of the missile is more effective; for a ball moving with great rapidity is more cleanly incisive, whereas a slow-moving ball lacerates and closes the vessels in its course. Hæmorrhage will be more or less free, accordingly. Partial division of an artery is attended with profuse bleeding, as retraction cannot take place. Puncture by a spiculum of bone, occasionally, will cause primary hæmorrhage; but a bullet may pass

between an artery and vein in contact, as the femoral vessels, without opening either vessel, their elasticity apparently preserving them intact.

The *pain* of a gunshot wound is worthy of notice as a symptom. In the first instance, it is either like the sharp stroke of a cane, or a dull heavy blow; differences due, perhaps, to the degree of contusion. The pain may be referred to a part remote, more or less, from the seat of injury. This want of localization, coupled with the inconstant and indefinite character of the pain itself, evinces its inferior *diagnostic* value as a symptom, compared with the signs already described. For a short time after the injury, the sensibility of the part is numbed; pain succeeding, and with increasing intensity as inflammation and tension supervene.

The symptoms connected with the penetration of *particular parts*—perchance the viscera—are specially significant, in virtue of the function of the part, which is thus injured; but as not pertaining to the general pathology of gunshot wounds, they are here omitted.

Causes; or Kinds of Projectiles in Gunshot Wounds, and the Effects of these Injuries.—The *shape* of projectiles used in warfare presents several varieties, the chief of which are spherical, as cannon-balls, grape, musket-shot, and shell; cylindro-conoidal, as balls belonging to rifled cannon and rifled muskets; irregular, but generally bounded by linear and jagged edges, as fragments of shells and splinters, chain and bar shot. In point of *size*, projectiles vary from a rifle bullet to the largest sized cannon-ball or shell. The shot used in civil life are usually of smaller size; as the bullet of a fowling-piece, or of a revolver or pistol; and game-shot of various sizes. The material and *density* of projectiles are less various; being either lead, as the common bullet, glass, as some hand-grenades, or cast iron, as cannon-ball or shell and all other missiles.

The *momentum* of a projectile is represented by its weight and velocity. The *velocity* of different kinds of projectiles varies considerably. According to a table published in 1851, the common musket bullet moves at the rate of 850 miles per hour, the rifle-ball of that date at 1000, and the 24 lb. cannon-ball at 1600 miles per hour. But the musket-ball then could not be depended on to hit an object beyond 80 yards, and the rifle not further than 200 to 250 yards; while, at a later period, the Enfield rifle was sighted to 900 yards, and the short Enfield to 1100 yards; and now, the Snider and Martini-Henry breech-loaders are true at certainly 1000 yards.

The *kind* of *motion* imparted to different projectiles, and thence their course through the air, is a difficult question, which can only be analyzed and determined mathematically, and is, in fact, a very important branch of dynamics. Different kinds of motion have to be considered in combination, and as resulting from the propulsive force, subject also to the law of gravity. A ball discharged from the old smooth-bore musket has a double motion; it revolves on its axis at a right-angle to the line of flight. A ball discharged from a rifle-bored musket or rifle has also a double motion, but of a different kind; it revolves on its axis in the line of flight. The *angle* at which a projectile strikes may be said to be accidental in many or most cases, and unconnected with the missile itself or its motion. Striking frequently at or nearly a right-angle, one kind of missile—the shell—exploding

on the ground, scatters its fragments upwards, and thus any such fragment will strike probably at an acute or obtuse angle.

The *penetrating* power of a projectile is determined mainly by its shape and velocity. The cylindro-conoidal form is very penetrating, in virtue of its mechanical advantage as a wedge. Thus, supposing one of the old musket bullets to strike a limb at 80 yards, and an Enfield rifle conical bullet of the same weight at 800 yards; the rate of velocity being equal in either case, the injury from the *latter shaped* ball may be expected to be much greater than that from the former. The influence of *velocity* is well known, and shown by the different effects of the same kind of missile according to its speed. A spent cannon-ball, rolling or bounding along the ground—ricochetting—may carry away a limb; whereas the same ball at full speed would level a line of men. But the former injury, occurring possibly when the cannon-ball is rolling along so slowly, as apparently to have no more force than a cricket-ball, shows also the influence of *weight* as an element of the momentum. *Density* is an important consideration respecting the power of penetration. For example, the projectiles and charges being of the same weight, when lead is used, the penetration at 800 yards is one-third greater from the Whitworth than the Enfield rifle; but, if a less yielding material be used, as when lead is mixed with tin, its penetration is as 17 to 4, at 800 yards. (Longmore.) The *kind* of *motion* has certainly some relation to the penetrating power of any projectile. If spinning, like a top, at a right-angle to the line of flight, as a bullet discharged from the old smooth-bored musket, the projectile is easily turned aside from its course; whereas the screw-motion of a ball discharged from a rifle-bored tube, coinciding with the line of flight, is very penetrating. Lastly, the *angle* at which a projectile strikes must affect its penetration. A right-angle will be more effectual than an acute or obtuse angle, the impinging body having a tendency to glance off in striking at the latter angle. *Small* shot, such as are used in civil life, seldom penetrate deeply; unless when discharged at a short distance, and entering in a mass, they thus resemble a bullet, or even a larger ball, according to the charge. When scattered and spent by a longer range, shot of small size are often found to have entered only skin-deep; but to have been deflected, probably, in all directions. Other bodies are sometimes associated with projectiles as *indirectly* causing wounds, additional, perhaps, to gunshot injury. Such missiles may be stones, splinters of wood or bits of iron from gun-carriages, portions of clothing or coins, and fragments of bone from a wounded comrade. Having borrowed their motion from the projectile itself, of whatever kind—perhaps a ball already spent—any such body strikes with a proportionately diminished impetus, and with different degrees of effect under various circumstanees affecting its own displacement, shape, and so forth.

The *effects* of a gunshot wound, *locally* and *constitutionally*, are quite *analagous* to those of a punctured wound, or of any contused and lacerated wound. Parts are damaged far beyond the apparent extent of injury. Thus, the textures are killed to a greater or less extent along the track of the wound, and a corresponding tubular slough is eventually formed. Shock, rather than syncope from sudden hæmorrhage, is the primary constitutional disturbance. This sloughing is more extensive, and the shock more overwhelming and prolonged,

when caused by projectiles of modern design; their more deadly character being due to their greater power of penetration.

Considerable importance has been attached to shock, in the sense of *concussion* of the whole body, by a heavy projectile, as a cannon-ball. But this can happen only when the velocity of any such projectile is so much reduced as to give time, in striking, to overcome the inertia of rest in the body. A cannon-ball at full speed may carry away a limb without knocking down the individual, who falls simply by the sudden shock of injury to the nervous system. Tetanus is of common occurrence. But its frequency has varied much in different campaigns, and under different climatic influences. In the Peninsular War, it was estimated to occur in about 1 case in every 200 wounded; in the Schleswig-Holstein War, 1 in about 350 cases. In the Crimea, tetanus appears to have been a rare event. Alcock's estimate of 1 case in every 79 wounded is too high. After naval engagements, the mortality has often been high. Sir G. Blane states that, after Rodney's action, out of 810 wounded 20 were attacked with tetanus, being 1 in 40. But sudden change from heat to cold is the most frequent cause of tetanus among the wounded. This was observed after the battles of Moskowa, Bautzen, Dresden, Chilianwallah, and Ferozepore. The above statistics include the proportion of cases of tetanus arising from all kinds of wounds, besides gunshot.

Course.—The vital career of a gunshot wound is analagous to that of a punctured wound, or of any contused and lacerated wound. *Gangrenous inflammation* invariably supervenes, perhaps extensively, along the track of the wound; and thus textures which may not have been killed more immediately, die subsequently. The *total* result is represented by the slough which forms. About the fifth day of a gunshot wound, this slough begins to loosen from the margin of either aperture, if two exist, and the line of demarcation between the living and dead tissues is clearly visible; about the tenth day, the slough or sloughs may be seen hanging out of the openings, and come away in the dressings. A tubular casting of slough had hitherto intervened between the living tissues surrounding the track of the wound, and prevented its union by adhesion. Suppurative granulations supervene, and the wound heals, or should heal, from within outwards.

Pending this process of reparation, tension is often extreme and extensive, and suppuration equally profuse and diffused. *Secondary* hæmorrhage is not an uncommon event. It occurs most frequently on the sixth day. (Baudens.) Arteries which did not bleed primarily, or which were only slightly grazed, may now burst forth. Or a spiculum of dead bone, during the course of suppuration, is occasionally the cause, by penetration of an artery. Any secondary hæmorrhage, if not suddenly fatal, may be uncontrollable, from its depth or in a disorganized part, or ultimately fatal in an individual already reduced by suppurative discharge.

An *unextracted ball* plays a singular part in the subsequent history of a gunshot wound. Constant suppuration, and exfoliation if the ball be lodged in bone, are consequences which might be expected. But the ball may move from its first lodgment and travel to some distance, in a devious course, and ultimately find an exit or still remain in the body. Various functional disturbances arise during these peregrinations. Again, the ball may become encysted in dense fibro-cellular

tissue, and then being stationary and isolated in a sac, it occasions little or no inconvenience. Or, a long canal-like cyst may form, in which the ball, although imprisoned, moves freely up and down. Apart from this general vital history, a gunshot wound extending into any internal organ, exhibits a series of phenomena peculiar to the particular organ implicated; and thence the completion of the vital history of this form of injury, as occurring in different parts of the body, belongs to Special Pathology.

Prognosis.—The prognosis of Gunshot Wound is partly analogous to that of any other contused or lacerated wound. The kind of structural *disorganization* is significant, as leading inevitably to sloughing and suppuration. The presence of any *foreign body* in the wound has a similar import. But the *extent* and the *depth* of a gunshot wound will much affect the issue. The prognosis is specially unfavourable according to the number and functional importance of the parts injured, as complications of the wound. Injury to large blood-vessels, nerves, or an internal organ, are thus, severally, unfavourable conditions; and proportionately to the functional disturbances thence arising. Compound Fracture and Compound Dislocation are obviously most serious complications of gunshot injury.

The subsequent course of the wound in its undergoing reparation by suppurative granulation, is an *eventually favourable* ground of prognosis.

Treatment.—*Immediately* after a gunshot wound, certain requirements demand instant attention, as to hæmorrhage, position, and shock.

(1.) *Arterial hæmorrhage*, whether in the form of a jetting stream or a rapid dripping of blood, must be arrested forthwith. Abundant venous hæmorrhage is scarcely less perilous. If a limb be the seat of injury, a tourniquet should be applied, so as to command the main vessels. The same rule holds good when the limb is struck off, as by a cannon-ball; a tourniquet should be applied above the stump. A convenient form of *field*-tourniquet is here represented. (Fig. 99.) In the absence of this instrument, a substitute may be readily made, by means of a stone about the size of an egg, rolled in the middle of a pocket-handkerchief and placed over the main artery; the ends of the handkerchief being drawn around the limb and secured in a knot, and then twisted up tightly with a piece of stick or the hilt of a sword passed under it. A compress and an elevated position of the limb are more suitable when the hæmorrhage is purely venous. The part may be covered with cold wet lint, as a soothing application. If the head or neck be wounded, hæmorrhage, whether arterial or venous, must be arrested by pressure; and cold applied.

Fig. 99.

(2.) Attention to *position* is important. A limb should be laid in an easy position; and fixed during the removal of the wounded person to Hospital, in order to prevent any disturbance of the injured part from shaking or from spasmodic action of the muscles. This precaution will be the more necessary when compound fracture or dislocation com-

plicates the injury. If the chest be shot through, the patient should be laid on the injured side and cold applied. If emphysema occur, or if air escape freely through the wound, a broad rib-roller should be applied. If the abdomen be wounded, the patient should be laid on the injured side; or, if the wound be central, on his back, with the knees drawn up over a pillow or knapsack. Any portion of protruding intestine or other viscera must be gently cleansed with water and at once returned.

(3.) *Shock*, or sometimes *hæmorrhagic collapse*, may be most perilous; and brandy, wine, or other stimulant must be administered to preserve life. Cold water may be given freely to allay the parching thirst which speedily ensues from loss of blood.

The *subsequent* indications of treatment comprise—the permanent arrest of hæmorrhage; extraction of foreign bodies; the management of inflammation, and sloughing; and the conditions requiring amputation.

(4.) *Hæmorrhage.*—The permanent arrest of hæmorrhage may first demand attention. If arterial, the application of a double ligature to the wounded vessel may be necessary; the wound being sufficiently enlarged perhaps by an incision for this purpose, and the vessel secured at not less than half an inch outside the course of the wound, that it shall be unaffected by sloughing of the textures, which would lead to secondary hæmorrhage. Whenever, therefore, the bleeding artery cannot be tied, with this precaution, owing to the depth of the wound, the main trunk must be ligatured. Yet this procedure should not be lightly entertained, considering the liability of thus inducing gangrene in a limb otherwise injured; as by ligature of the subclavian, or of the femoral artery. And, moreover, secondary hæmorrhage not unfrequently occurs. But it is seldom requisite to have recourse to ligature of even the wounded artery for primary hæmorrhage after gunshot injury. When a limb is torn off, leaving a stump, the lacerated vessels soon cease to bleed. Venous hæmorrhage must still be arrested by pressure, and elevation of the limb. The application of a roller-bandage is advocated by Hamilton as a very effectual means of preventing extravasation of blood and serous effusion. But it should not be continued after inflammation has set in—say, not beyond the first twelve or twenty-four hours.

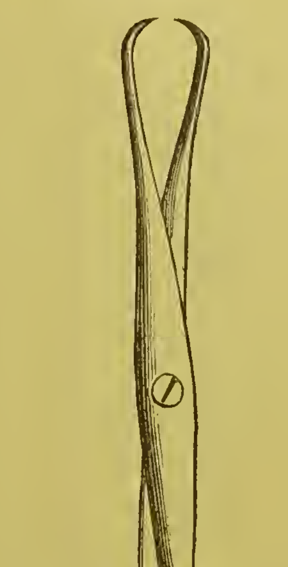
Other indications for interference with the wound are best determined by examining the patient in the position, as nearly as it can be ascertained, in which he was relatively to the projectile that struck him. In any other posture, the apparent course of the ball in the body, and thence also the probable extent of injury or the parts implicated, would be modified by muscular action and by the various degrees of elastic retraction of the wounded textures. The relative situations of the rent in the clothing and the entrance-opening in the flesh, should also be compared.

(5.) *Foreign Bodies.—To detect* any such substance, the finger is the best searcher or probe. Various forms of gunshot probe have been devised; an instrument provided with a bulb-end being the most serviceable. In case of doubt or difficulty of examination as to the lodgment of a *leaden* bullet, Nélaton's probe, having a bulb of unglazed porcelain, should be introduced; and if, in firmly touching the foreign body, its point receives a metallic mark, as shown when

the probe is withdrawn, this instrument will thus offer the requisite facility and certainty of diagnosis. In the well-known instance of Garibaldi, it will be remembered that a ball was detected with this instrument by Nélaton, after search had been otherwise made, repeatedly in vain. A probe should be introduced lightly, or dropped into the wound, not to miss the track of the ball; any thrust of the instrument might make a false passage; but if in the right course, the probe can be advanced almost by its own weight towards the ball, while the Surgeon endeavours to overcome any hitch, by adapting the position of the part so as to restore the track. The finger or a probe will glide most readily in the course which the missile has taken; the tissues having been thrown down in this direction, as grass falls before the wind.

Enlargement of the Entrance-Aperture.—A slight incision is sometimes absolutely necessary for the removal of a *bullet* or other foreign body; but the rule of practice which formerly prevailed of invariably enlarging the aperture by incision and to some considerable extent was an error; suggested by the false pathology of thus converting a supposed "poisoned" wound into a simple incised wound, and of giving free vent to the noxious discharge. Any foreign body, of *irregular* shape, *e.g.*, a fragment of shell, more generally needs release to effect its dislodgment and extraction; the circumstances in this case at once showing the necessity, and regulating the extent, of incision. But unless for an obvious purpose, the *rule* should be to avoid making any enlargement of a gunshot wound, as being an extension of the original injury.

Fig. 100.*

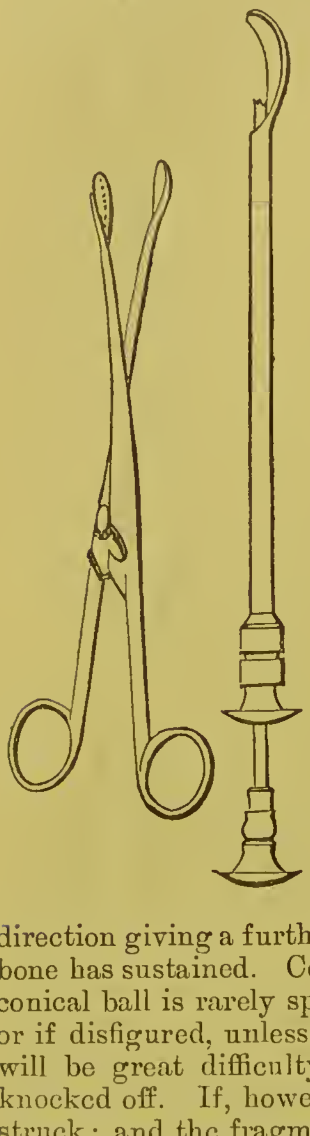


To remove a bullet some form of bullet-extractor is generally requisite or advantageous. The most convenient form is here represented. (Fig. 100.) The sharp points of this instrument will readily seize a leaden bullet. Any kind of forceps is somewhat objectionable, owing to the dilatation of the textures in using the instrument. A bullet lodged in *bone* may be extracted by an elevator, aided by gouging away any overhanging portion of bone. Any other foreign body, as a portion of clothing, which might be mistaken for some natural texture, should be searched for with the finger and removed by manipulation rather than with forceps, which are apt to seize both indiscriminately. Examination of the dress will probably show whether a portion was carried with the shot into the wound. It should, however, be remembered that any such fragment may have been withdrawn in undressing

* Luer's bullet-extractor, which was used generally in the Franco-German War. (Weiss.)

the patient. Foreign bodies are *eligible* for removal, according to the patency of their situation, as their presence can then be ascertained with proportionate certainty; but the relation of surrounding parts will affect the *safety* of an operation for extraction. Thus, when situated beneath the skin, although perhaps at some distance from the entrance-aperture, a bullet is readily detected and removed by an incision, longer than the apparent size of the ball, care being taken to steady the ball lest it slip away out of reach. The bullet is usually found to be more or less battered and misshapen, also tightly constricted and held fast by diverted threads of muscular, fibrous, or cellular texture; the missile, thus imprisoned, cannot be raised from its bed, and must be set free by touches with the knife, before it can be extracted, without further laceration of the textures and unnecessary pain. A conoidal ball generally lies with its long axis sideways beneath the integument, and should be extricated in that direction.

Fig. 101.



On the other hand, when the foreign body is situated deeply, and possibly already out of reach, its detection is less certain—unless it be a leaden bullet, the presence of which may be recognized by means of Nélaton's probe; and its extraction, in any case, by operation, will be less safely accomplished. The annexed form of bullet-forceps, Savigny's (Fig. 101), is specially serviceable for deep wounds. The blades unlock, and can be introduced separately, or used as a scoop. Cozeter's bullet-scoop (right object in Fig.) enables the Surgeon to fix the bullet by means of a screw. But when the foreign body is so placed that it cannot be distinctly localized, or should it be inaccessible surgically, the better rule of practice is to abandon any further research, as well as any attempt at operative interference. This injunction becomes absolute in the case of a foreign body lodged in any internal organ.

Sometimes a *counter-opening* affords a more ready access to the ball; and then, when extracted, the missile should be carefully examined, to ascertain whether it has been chipped, by coming in contact with bone, and that the fragment is probably left in the body; or whether, judging from its misshapen, although unbroken appearance, the ball has struck bone, directly or obliquely, this relative direction giving a further indication as to the amount of injury which the bone has sustained. Certain difficulties attend both these questions. A conical ball is rarely split; and unless the ball retain its regular shape, or if disfigured, unless it be much reduced in size and weight, there will be great difficulty in determining whether any portion has been knocked off. If, however, a piece has been left, bone must have been struck; and the fragment will be diverted from the course of the ball, so as perhaps to elude any further search. The misshapen appearance

of the ball may also show that bone has been struck; but only when it is flattened at its conical point, or deeply furrowed on one side, can the inference be warranted that the missile impinged directly, in such case producing fracture, with extensive comminution; whereas, an oblique stroke, grazing the bone, may not cause fracture, or if so, without comminution. In connection with this examination of the ball, the possibility should not be overlooked that similar alterations of size and shape may have been produced by impingement against some hard substance, before entering the body; as by striking a button, or a sword, upon the person of the wounded man. In comminuted fracture, any loose fragments of bone should be removed. *Gunpowder grains*, scattered beneath the skin, appear as black specks, and are perceptible to the touch; they may be picked out with the point of a probe, though rather firmly imbedded. If allowed to remain, these granules induce some redness and swelling, followed perhaps by suppuration and their discharge. But, usually, a pointed marking remains—the part is tattooed. The grains can be disinterred only by incision with a sharp-pointed bistoury, and even then the stain left is never effaced.

An ordinary gunshot wound, having one or two, possibly more, openings, with an intermediate line of texture about to slough, is a kind of lesion which requires little or no external *dressing*. The apertures may be protected from exposure to dirt by corresponding pieces of wet lint, or when fresh water cannot be procured, as perhaps at sea, simple cerate on lint will be a sufficient substitute; but any *restrictive* dressings, which would preclude the escape of sloughs and the discharge of pus, are altogether at variance with the suggestions of pathology. An irregular and lacerated wound, as by a piece of shell, may need such dressings, but merely so as to adjust and retain the textures in *position*. Or, during a journey by land, as when recently wounded men are transferred to some distant hospital, their wounds, tender and irritable, may be *protected;* a broad compress of cotton or other soft padding, applied over the dressing, and lightly retained by plaster, will prevent any chafing of the clothes or other injury, and also afford great comfort.

(6.) The accompanying *inflammation* and tension with severe pain are perhaps best moderated by warm water fomentations; but the choice of warm or cold and evaporating applications, must be guided by experience and trial in each case, and especially by the sensations of the patient, rather than by any pathological consideration at present known. *Early* and *free incisions* may be requisite to relieve tension and thence the accompanying constitutional disturbance, and to give free vent to matter which otherwise accumulating would burrow and disorganize the part. This relief of tension will also limit the sloughing. The irrigation of cold water has sometimes proved very beneficial, apparently in cleansing the wound of any excessive discharge, or decomposing texture, and thence also in the prevention of pyæmic infection. Subsequently, the process of healing by granulation and cicatrization guides and regulates whatever slight assistance may then be necessary on behalf of reparation.

Of the *untoward* events to which a gunshot wound, in general, is liable; *secondary* hæmorrhage is one. It is especially apt to occur when the sloughs loosen and separate—about the fifth or sixth day;

but it may happen during a period from that time up to the twentieth or thirtieth day, when any ligatures separate, and commonly about the fourteenth day. At those times, therefore, the application of a tourniquet around the limb, in readiness to be tightened at a moment's notice, will always be a judicious precaution, but only as a temporary measure to arrest the hæmorrhage. Ligature of the bleeding vessel or vessels is imperative, and without delay. This should be done *in situ*, if possible; or when impracticable, then by ligaturing the main trunk; or *that* failing to command the hæmorrhage, amputation is the only resource. A general oozing of blood, or "parenchymatous hæmorrhage," may be subdued by dilute solutions of perchloride or persulphate of iron, or other astringents. Any loose fragment or speculum of dead bone, as an accidental cause, should be removed; although, sometimes, not without the danger of provoking erysipelas. The probability of *gangrene* supervening, and thence the propriety of amputation, and the question whether it should be primary or secondary, are subject to the same or analogous considerations as with regard to contused and lacerated wound, and to compound fracture or dislocation.

(7.) *Amputation.*—When a limb is the seat of gunshot injury, requiring amputation, the evil consequences of delay are vividly portrayed by Sir Charles Bell, in the following course of such cases:—"In twelve hours, the inflammation, pain, and tension of the whole limb, the inflamed countenance, the brilliant eyes, the sleepless and restless condition, declare the impression the injury is making on the limb and on the constitutional powers. In six days, the limb, from the groin to the toe, or from the shoulder to the finger, is swollen to half the size of the body; a violent phlegmonous inflammation, with serous effusion, has taken place in the whole limb, and abscesses are forming in the great beds of cellular texture throughout the whole extent of the extremity. In three months, if the patient have laboured through the agony, the bones are carious, the abscesses are interminable sinuses, the limb is undermined and everywhere unsound, and the constitutional strength ebbs to the lowest degree."

Keeping in view a clinical history such as this, Surgeons are now generally agreed on the great advantage of primary, instead of secondary, amputation, in gunshot injury, an advantage which is fully borne out by statistical results; but the only question has been the kind or class of cases requiring amputation.

The following *conditions* of gunshot injury may be enumerated, as those which justify amputation, according to the "Report of the United States Commission," 1864. (Hammond's Military Essays.)

(1.) Cases where a limb is nearly or completely carried away, leaving a ragged stump, with laceration of the soft parts, and projection of the bone.

(2.) Cases in which the soft parts of a limb are extensively lacerated or contused, the principal arterial and nervous trunks destroyed, and the bone denuded or fractured.

(3.) Cases in which a similar condition exists, without either fracture or denudation of the bone.

(4.) Cases of compound and comminuted fracture, particularly those involving joints.

(5.) Cases in which the ball does not actually penetrate the joint,

but in which, the bone being struck above or below, the fracture extends into the joint.

(6.) Respecting the *lower* limb:—

Compound fractures of the middle and lower part of the thigh, occasioned by gunshot, require amputation.

In the upper two-thirds of the thigh, with similar gunshot injury, the mortality following amputation has been so very great, that army surgeons have generally abandoned the operation. On the other hand, this experience should be supplemented by the counter-fact that such injuries rarely recover. Six cases, however, in the upper third of the thigh, are reported to have occurred during the Crimean War. (Longmore.) We may therefore join issue with the Surgeon-General of the United States Army, in the conclusion that such cases must be left to the judgment of the surgeon.

(7.) Gunshot wounds of the knee-joint demand amputation. Excision has not been attended with favourable results.

The conditions of gunshot injury to the lower limb, which do *not* necessarily require amputation, are:—

(8.) Fractures in the middle of the leg, unless the arteries are destroyed, or the injuries involve the neighbouring joints.

(9.) In the case of the ankle-joint, if the posterior tibial artery and nerve have escaped injury, and if the bones be not extensively comminuted, an attempt may be made to save the limb.

(10.) Respecting the *upper* limb:—

In gunshot injuries of the shoulder and elbow joints, provided the main blood-vessels and nerves are not involved, excision may be practised with a fair prospect of success. Thus, in 14 cases of excision of the shoulder-joint, by M. Baudens, as performed for gunshot injury, 13 were successful. During the Crimean War also, Mr. Thornton states, that of 12 cases of shoulder-joint excision, 2 only were fatal; and in 17 of the elbow-joint, only 2; while 5 partial excisions of the joint were all of them successful. In the Russian army, we gather from the report by Messrs. Mouat and Wyatt, that of 20 elbow-joint excisions, 15 recovered.

(11.) Gunshot wounds penetrating the wrist, unless accompanied with great laceration, do not necessarily demand amputation.

(12.) Gunshot wounds between the phalanges of the fingers or toes, may also be exempted.

(13.) Before proceeding to any amputation on account of gunshot injury, great care should be taken to discover whether the patient may not be otherwise mortally wounded.

In duly considering whether amputation should be *primary* or *secondary*—to give the limb *its* chance—the large proportion of unfavourable or fatal results of secondary amputation, must ever be taken into account. During the siege of Sebastopol, there were 3000 amputations, among 80,000 wounded Russians. Of the primary amputations of the upper extremity, of the lower and middle third of the thigh, of the leg, and foot, about one-third recovered; but of all the secondary amputations, more than two-thirds died. These results are more than corroborated by those in previous wars. Thus, primary amputation was successful in three-fourths of the cases, under Larrey, during the Napoleonic Wars; whereas, of 300 secondary amputations, reported by Faure, after the battle of Fontenoy, 30 only were successful. In

the Peninsular War, the loss after secondary amputations of the upper extremity was, as compared with the primary, as 12 to 1; and of the lower extremity, the loss was three times as great. As the result of a very complete statistical inquiry, Dr. Stone, of the Bellevue Hospital, New York, arrives at two conclusions:—That, with regard to the upper extremity, primary amputations are to be preferred, both in military and civil practice, being more successful than secondary in both; and that in the lower extremity, primary amputations are three times as successful as secondary, in military practice. (N.Y. "Journal of Medicine.") Comparing amputation, both primary and secondary, with no amputation—an attempt to save the limb—it would appear that the risk of failure or the relative mortality is at least equal! This conclusion is supported by Bilguer, and by Malgaigne's experience in Poland, where—in an army of 80,000—after amputation of the lower extremitity, not one case survived. *Immediate* amputation—without any delay, if possible—offers the advantage of performing the operation in the absence of shock. This favourable opportunity would appear to be due to the elation of the soldier "while in heat and mettle," as Wiseman suggested; and the beneficial influence of this state has been recognized by Paré, Larrey, John and Charles Bell, Hennen, Guthrie, and other surgeons of experience; and which was verified by not a few instances during the Crimean campaign. Hamilton concedes the advantage of immediate amputation in some cases of severe injury to a limb; as when there is uncontrollable or recurring hæmorrhage, or if there be intense or irrelievable pain, from displaced spiculæ of bone which cannot be extracted; and that this early period of operation will always be suitable for all the smaller amputations, as of the fingers and toes. *Intermediate* ampntation—in the period between that which is either primary or secondary—is now generally acknowledged to be the most unfavourable time; that interval not being safer than within the first twenty-four or thirty-six hours, when shock has passed off—the period for primary amputation; but which is succeeded by congestive infiltration or acute inflammation; and the consequences of which in suppuration and exhaustion are apt to render secondary amputation so disastrous.

The *seat* of amputation should always be guided by the cardinal rule of preserving as much of the limb as possible, having regard to the nature and extent of the injury, not only for the formation of a more useful stump, but also in relation to the safety of life. The nearer to the trunk, the greater the danger of amputation for gun-shot injury, in common with other injuries, and especially when the lower extremity is submitted to the operation. Thus, amputation through the thigh, in its upper third, is most fatal; the death-rate rising to 86 per cent., or even higher. This was alike the experience of English, French, and Russian surgeons, during the Crimean War; and it was confirmed by the results in the American War. Amputation *through a joint*, rather than in the continuity of a long bone, has yielded more satisfactory results, both in regard to the stump, and the comparative mortality. The former is certainly a more convenient operation, where time is precious to the operator, as in service on the field. And looking at the results collected by Dr. Stephen Smith, it appears that in 86 cases of amputation at the knee-joint, 49 recovered, and 37 died, showing a mortality of only 43 per cent.; as compared

with 64 per cent., after amputation in the thigh, during the American War.

The *method* of amputation—whether by the circular operation, or by flaps—is a question worthy of consideration, principally with reference to circumstances, relative to the operator and the patient after operation. Thus, in amputations on the field, and performed necessarily under the pressure of time, flap amputation is more expeditious; but if time permit, and the patient is likely to be conveyed to some distance soon after operation, circular amputation will be preferable, considering that heavy, and perhaps swollen flaps, shaken by the motion of carriage, are apt to loosen and become gangrenous. This difficulty was experienced during the Crimean campaign, among the cases of amputation subjected to journey by land, and even when the patients were conveyed by sea, in the transports to Scutari.

The general treatment, hygienic and medicinal, in relation to gunshot wounds, is the same as, under similar circumstances, with regard to other contused or lacerated Wounds, Compound Fracture, and Dislocation. Hygienic measures are chiefly important, and they claim special attention in Military Camp Hospitals; where, owing to the contingencies of warfare, regimen, ventilation, and general cleanliness are more than usually liable to be defective.

CHAPTER XIX.

MORBID CICATRICES.

Morbid Cicatrices are either failures of reparation in the healing of Wounds and Ulcers, or various conditions of its results, in the form of faulty cicatrices. They comprise:—(1) Deficient Cicatrix; (2) Excessive Cicatrix; (3) Painful Cicatrix; (4) Ulceration, Growths, and Degenerations of Cicatrix.

(1.) *Deficient Cicatrix.*—A thin, flat, shining, reddish, easily wrinkled and cracked scar remains, after the imperfect healing of a weak ulcer or scrofulous sore. Such a result depends obviously on deficient reparative power of cicatrization.

Treatment.—Pencilling with nitrate of silver, sulphate of copper, or other stimulant application, and protection of the surface from any external occasion of inflammation or injury, constitute the most probably successful topical treatment. At the same time, the general health must be improved as far as possible, thus having regard to the constitutional causative condition.

(2.) *Excessive, and Exuberant or Cheloid Cicatrix.*—An opposite condition to the preceding; this form of cicatrix is thick, more or less projecting, irregular, dense, and perhaps adherent. *Contraction* of such a cicatrix is not an uncommon character, and the force thus exerted may be so powerful and long continued, as to produce great displacement and deformity. This result usually follows cicatrization after a burn, particularly if it be deep and extensive.

Cheloid or exuberant cicatrix is well defined, gradually rising, with a rounded border, and a smooth, level, or slightly convex, or sometimes centrally depressed surface. Its substance is always tough and firm, becoming more so as it grows older. At first, usually more vascular than even a recent healthy scar, and having a florid or purple tint; it gradually becomes paler as it becomes harder, and at length resembles healthy exuberant skin. In point of structure there is nothing peculiar; compact fibro-cellular tissue more or less completely developed or degenerate, and slightly vascular, is covered with a thin cuticle. The size of a cheloid growth is generally distinctive; rarely more than half an inch in thickness, or more than half an inch in any direction beyond the extent of scar in which it grows, the growth thus differs from a fibrous growth of skin which it nearly resembles. Exuberant cicatrix may arise from some local cause of irritation during cicatrization, or some more obscure cause of a constitutional character. The latter would appear to be the origin of this cicatrix; considering its infrequency as compared with the frequency of wounds and scars, and that many such growths may appear in the same individual, and reappear in the scars of wounds made for their removal. It occurred as the result of confluent small-pox, in a remarkable case under my observation; the face presenting a seamed cicatrix, having a trellis-work appearance. Cheloid cicatrix may supervene on a completely formed healthy cicatrix, and even long after it has remained so; it grows slowly, and generally, after a long duration, ceases to enlarge or diminishes, and it is liable to degeneration and ulceration.

Treatment.—Strong stimulants, applied repeatedly, have some effect in dispersing an *excessive* cicatrix; apparently by inducing or favouring degeneration and disintegration of the already imperfectly developed fibro-cellular tissue, and thus facilitating its absorption. Further growth may at least be retarded or prevented in like manner. Iodine paint and mercurial ointments will perhaps prove the most effectual of these applications. *Adhesion* of the cicatrix to subjacent textures and to bone, is best overcome by subcutaneous division, as was, I believe, originally recommended by Mr. Hancock. A cicatrix, hitherto intractable, will, when thus detached, contract, and not unfrequently close in rapidly. *Contraction* of the cicatrix, as after a burn, is more preventable than curable. Mechanical restraint by some form of contrivance adapted to the situation and extent of the ulcer, and applied as soon as the eschar is detached, will perhaps prevent the effects of contraction. Counter-extension, by similar means, in the direction of contraction, will less surely overcome its effects. But it may be necessary to continue such resistance for weeks or months; often taxing the ingenuity of the Surgeon, and trying both his perseverance and that of his patient. In accordance with pathology, the general principles to be here observed are the following:—"That scar-tissues seem rather to adapt themselves by changes of nutrition to the external forces brought to bear on them, than to be merely stretched by them; that, in however long a time, the natural course and tendency of scars is to soften down to a greater resemblance to the natural parts in both structure and relations; and that they are of low vital power, apt, therefore, to waste or ulcerate quickly under irritation, friction, or pressure, and are thus removable by absorption." (Paget.)

Cheloid cicatrix is removable only by excision, complete extirpation

being necessary, and not even then a guarantee of non-recurrence; but a recurrent growth of this kind is not more intractable than the original one.

Plastic operations, planned according to the particular case, are available for the cure either of excessive or of cheloid cicatrix. The chief general rules for such operations may be thus stated:—That if the scar is to be removed, so as to bring healthy structures together for union in its place, no portion whatever of its substance should be left; that scar-tissues should not be used for the formation of flaps, or relied on for any speedy or sound union; that if the scar or part of it is to be included in any flap for sliding or transplanting, all the borders and surfaces of such flap intended for union should, if possible, be of healthy structure, and not themselves parts of the scar; and that flaps should not be dependent on scar-tissues for their supplies of blood.

(3.) *Painful Cicatrix.*—Commonly arising from adhesion of the subjacent nerves to the skin or bone, and not attributable to bulbous enlargement of their cut extremities; the cicatrix of any wound may thus be painful, although most frequently that of a stump after amputation. Usually, the cicatrix-tissue is sound, but the nerves are subject to constant irritation or inflammation, varying with the mobility and movement of the part. *Neuralgic* pain, of an excruciating and paroxysmal character, is due rather to some constitutional cause affecting a cicatrix, still healthy in itself. This condition may supervene long after the cicatrix is completely formed, and has loosened from any subjacent adhesions in the natural course of healing.

Treatment.—Free subcutaneous section is almost sure to prove remedial, when the pain arises from *adhesion* of the cicatrix. It is readily accomplished by introducing a tenotomy knife from the centre of the part, which usually remains open as an intractable ulcer, and sweeping round the cicatrix, to beyond its circumference. In this way I succeeded in permanently curing a painful, adherent cicatrix over the projecting head of the astragalus, after Chopart's operation. I found it necessary, however, to remove a portion of the bone, in order to bring the margins of the ulcer together; and to divide the tendo-Achillis in order to prevent retraction of the stump and tilting forward of the astragalus, as was the case before the operation. The result was that the pain ceased and the ulcer healed over the stump, the tendon was lengthened by gradual extension of the foot after operation, and the man walked well on the flat of the stump to the ground. This result was the more noteworthy, considering that, as a crucial experiment, I had previously divided the tendo-Achillis without any effect on the cicatrix. After amputation in the upper third of the leg, I have had recourse to subcutaneous section of the cicatrix, when adherent to the tibia. Neuralgic pain can only be cured, if at all, by constitutional treatment; chiefly by quinine, and careful regulation of the bowels. The topical application of aconitina will often temporarily allay this pain; a grain of the best preparation of the alkaloid to a drachm of lard, in the form of an ointment applied from time to time.

(4.) *Ulceration*, and other morbid changes, *growths* and *degenerations*, affecting cicatrix-tissues, follow the same pathological laws as in other structures; and are amenable to the same *treatment*, accordingly.

CHAPTER XX.

BURNS AND SCALDS. LIGHTNING. FROST-BITES.

Burns and Scalds.—*Structural Conditions, and Diagnostic Characters.*—Formerly, burns were classified according to their different degrees of structural disorganization, as represented by inflammation, suppuration, sloughing, and ulceration. Fabricius Hildanus, Boyer, and Dr. J. Thomson observed only three degrees of disorganization; Heister and Callisen recognized a fourth; but Dupuytren was dissatisfied with this ground of classification, which regarded only the intensity of the burns, while the nature of the parts affected, the *textures* injured or destroyed, were altogether disregarded. He therefore superadded this kind of classification, by distinguishing burns according to their various degrees of *depth*, from the surface inwards to deeper parts.

Firstly.—Erythema, or simple reddening of the skin. Secondly.—Vesication, the cuticle being raised in blebs, filled with serum. Thirdly.—Incomplete destruction of the skin. Fourthly.—Complete destruction of the skin, extending down to and involving the subcutaneous cellular texture. Fifthly.—Conversion into eschars of muscles, nerves, vessels, and other soft tissues to within a variable distance from the bone. Sixthly.—Charring and complete disorganization of the whole substance of the burnt part. Obviously, this classification recognizes not only the various degrees of disorganization, beginning with erythema and ending with charring; but the various kinds of tissue, or *anatomical* differences, are also recognized as grounds of distinction. Thus may be enumerated burns of the skin, and those involving the cellular texture, the muscles, nerves, vessels, and so forth.

The distinctions laid down by Dupuytren, although still generally accepted, are, I conceive, practically useless. *Deep* burns, to the fourth, fifth, and sixth degrees, extending successively through tissues having very different anatomical characters, are not attended with correspondingly different degrees of shock; they undergo the same process of reparation by sloughing and suppurative granulation, and with equal probability of recovery. It should also be observed that, as the textures successively destroyed by deep burns serve very different functions in the animal economy, the relative importance of such burns is not proportionate to the *physiological* character and importance of the parts destroyed. Nor, again, is the Surgeon concerned with the *pathologico-anatomical* differences of burns. He estimates not the effects of heat on the body by observing the different degrees of disorganization produced in the various textures—that this eschar is yellow and hard, and that is black and brittle—as the geologist or mineralogist would examine specimens of igneous rocks.

Superficial burns are most important, and in proportion to the *extent* of surface affected, but not necessarily destroyed structurally. The more superficial the burn, the more the skin alone is affected. if only extensively, the more urgent will be the constitutional disturbance, and the more dangerous is the burn. A negro employed at the Bains Vigier, in Paris, wishing on one occasion to warm his limbs,

which were benumbed with cold during a rigorous winter, immersed himself in a bath heated to a high temperature. In a short time he experienced a general feeling of uneasiness, with acute pain in the skin. He was immediately withdrawn and carried to the Hôtel Dieu, where he expired in thirty-six hours! It is reasonable to suppose in this case, that although the water was heated to a high temperature, yet it was not at the boiling point, and that it acted only as a general rubefacient, without raising or destroying the cuticle; and yet here was a burn of only the first degree, but very extensive, and therefore accompanied with a shock to the nervous system, so sudden and overwhelming as soon to have proved fatal.

Deep burns, when not superficially extensive, are of comparatively subordinate importance; their significance having reference generally to the remote consequences of such burns, by exhaustion from sloughing and suppurative discharge.

Causes, and their Effects locally and constitutionally.—Heat applied to the body is necessarily the cause in all cases; but it may have been either by fire, as by the clothes catching fire, the explosion of gunpowder or other explosive compound; or by means of a hot or scalding fluid, as boiling water or molten lead. The lesions produced in the former way are commonly designated *burns;* in the latter way *scalds.* This distinction is of practical consequence; burns not unfrequently resulting from the more prolonged application of heat, are deeper lesions, but perhaps of less superficial extent; scalds resulting from the more momentary application of heat, are more superficial, but generally they affect a larger extent of integument. Any adhesive fluid, as boiling oil, is a more persistent cause, and boiling perhaps at a higher temperature than water, it affects the tissues to a greater depth, as well as superficially. Some such fluids, clinging to the skin, run over a yet greater extent. Thus, then, scalds may be even more severe than burns, by the *duration* of the cause; the amount of lesion, superficially and in depth, being perhaps equal.

Explosive compounds are destructive, not only as causing burns of considerable extent, but also by the mechanical violence of their explosion, producing wounds which might be called *burnt* wounds, contused and lacerated. Grains of gunpowder, grit, mud, or other material may, moreover, be introduced as foreign bodies into such wounds. Wounds of this kind were well marked in the persons of the unfortunate victims of the "Clerkenwell Explosion," admitted under my care into the Royal Free Hospital. In all cases, the wounds were not only lacerated, and ingrained with dirt, as if portions of flesh had been gouged out by extremely forcible splashes of mud; but the surface of these wounds and surrounding integument were apparently burnt and contused by the concussive atmospheric force of the explosion. All the wounds sloughed for some time, with a yellow, and freely suppurating surface; healing very slowly by granulation. The cicatrix contracted, and assumed a seamed, puckered appearance, notably in the wounds of the neck; just like the cicatrix presented by the healing of a burn.

Burns and scalds immediately induce pain and shock, both of which are more or less severe according to the superficial extent of lesion. The symptoms of shock, affecting the nervous system and circulation, are the same as those arising from any other injury. But

it is accompanied with congestion of internal organs; the brain, lungs, and mucous membrane of the gastro-intestinal canal. The duration of collapse is variable, averaging about 48 hours—two days.

Course and Terminations.—(1.) *Shock*, or *Congestion*, proves fatal in many cases within the first two days; and indeed of all the fatal cases of burn, a great majority die in this period. Mr. Erichsen collected 50 fatal cases, and Mr. T. Holmes 75 such cases of burn; the former, with a view of determining the organs most frequently affected in each degree and period; the latter, with the special view of determining the mode and cause of death. Of the whole 125 cases, 35 died on the first or second day; but as the great majority of those who are burnt to death are not examined, the proportion is much greater than this. Thus, of 119 other cases brought to St. George's Hospital, 79 died in this period. In 16—Erichsen's proportion—of the 35 cases, the brain and its membranes were found congested, with more or less serous effusion into the ventricles or arachnoid, in 15 cases. The brain in the other case was not examined. In the remaining 19 cases, the brain was examined only in a few, but in 1 only was it healthy in respect of structure and vascularity. The thoracic viscera were congested in 8 of the 16 cases, and in 6 of the 19 cases; the congestion having passed into demonstrable inflammation in 1 of the former, and in 3 of the latter; thus making thoracic congestion in one-half the cases examined. The abdominal organs were somewhat less frequently congested; in 12 of the 16 cases, in 3 only of the 19. The mucous membrane of the pharnyx and larnyx is extremely liable to be congested, apparently owing to the inhalation of flame or heated air during the accident; of the 19 cases collected by Mr. Holmes, which died in the first two days, some appearance of this kind was found in 13. The congestion in the pharnyx very generally ceases abruptly at the commencement of the œsophagus; in some rare cases passing down into the stomach.

(2.) *Reaction* and *Inflammation* constitute the next, or second period; extending from the end of the second day to the end of the second week. During this period, 25 out of the 50 cases died; and 29 out of the 75 cases; or 54 out of 125. The brain, lungs, and intestines are the viscera principally affected; laryngeal cases usually die earlier. In the 25 cases, the brain was affected in 14; 11 being simple congestion, and 3 serous effusion. Of the 29 cases, the brain was not examined in the great majority; in 3 it was congested, with effusion into the ventricles or arachnoid; but there was no evidence of true inflammation in any case. The lungs are more frequently affected. In the 25 cases, these organs were congested in 10 cases, and inflamed in 5. Of the 29 cases, inflammation of the lungs or pleura had occurred in 7 (in one of which, however, it probably existed before the accident), and congestion was noted in 5 others. The abdominal viscera—liver, spleen, or kidneys—are perhaps never affected as a consequence of burns, except by pyæmia. But the mucous membrane of the gastro-intestinal canal is usually inflamed, and probably ulcerated; with, in some cases, evidence of peritonitis. Inflammation followed by ulceration of the duodenum is a notable occurrence, in the second period of burn, to which Mr. Curling first drew attention. In the 25 cases, ulceration of this portion of intestine was found in 6; in the 29 cases, in 4 of them; making a total of 12 such cases out of 54. In 3 more of

the latter series, enlarged glands were found, in 1 of which cases the glands of the whole intestinal tract were enlarged.

The *duodenal ulcer* is sharp-edged, and tolerably circular, as if a portion of the mucous membrane had been cut out; it is very indolent, and usually situated just below the pylorus. Often there are two or three close together. Generally, the burn is on some part of the chest or abdomen. The earliest known period of duodenal ulceration is the fourth day; on the fifth day, it was noticed in two cases, and in one on the sixth. It usually occurs about the tenth day. This ulceration is unaccompanied by general inflammatory symptoms, or by any special symptoms. Persistent vomiting and bloody diarrhœa are the most reliable. Perforation of the bowel may ensue, and death take place suddenly from hæmorrhage, or from acute peritonitis. In one case, however, after death from other causes, at the end of eight weeks, a recent cicatrix was found in the duodenum.

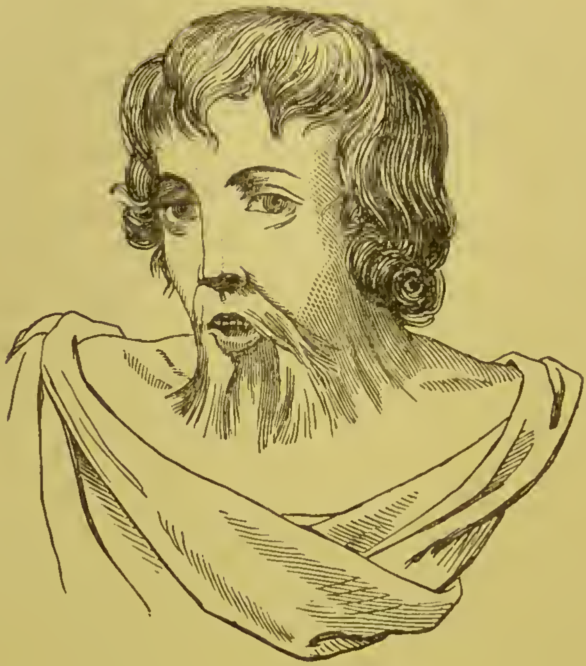
(3.) *Suppuration* and *Exhaustion*, or *Inflammation* still prevailing, represent the third period; extending from the end of the second week to the termination of the case. The proportion of deaths at this period was 9 in the 50 cases—less than $\frac{1}{5}$, and 27 in the 75 cases—more than $\frac{1}{3}$. Brain lesions are accidental, being limited to infantile convulsions and pyæmia. The lungs or pleuræ are far more frequently congested or inflamed, and this condition is the cause of death. Thus, in 6 out of 9 cases examined in Mr. Erichsen's table, lesions of the lungs and pleuræ were noted. In 4 of these, the appearances were distinctly inflammatory; in the other 2 there was congestion with effusion into the pleuræ. Out of 27 of Mr. Holmes's fatal cases—during this period—the lungs were affected in 10, in 8 of which inflammation was the principal cause of death. Here, generally, the burn is situated on the chest. The symptoms—physical examination being precluded—are sufficiently marked; pain and oppression of breathing, hacking cough, and bloody expectoration. The gastro-intestinal mucous membrane is less frequently congested or inflamed, but ulceration of the duodenum is still not uncommon. Out of the 27 fatal cases referred to, in 6, open ulcers were found in the duodenum; in 1 a similar ulcer had cicatrized, and in 1 the whole mucous membrane of the small intestines was inflamed but not ulcerated. In the other 9 cases referred to, no ulceration of the intestines was discovered. In 1 case only of Mr. Holmes's series, the jejunum and ileum were ulcerated, the duodenum being intact.

Reparation.—Burns and scalds heal by the same process of reparation as similar lesions otherwise caused. But some features in their career are peculiar. Erythema, produced by a burn or scald, tends to subside, like any other simple cutaneous inflammation; resolution taking place with desquamation of the cuticle. Vesication also is resolved and terminates in like manner. Deeper burns involving, successively, the skin, subcellular tissue, and other adjacent textures, are followed by sloughing, with the formation of eschars, abundant suppuration, and then the healing process of granulation and cicatrization. But the granulations are exuberant, and the *cicatrix* is *contractile.* At first thin, of a purplish colour, and shining, stretched appearance, it immediately begins to contract, and contraction continuing for some months, with great and increasing force, the cicatrix gradually assumes a seamed and puckered appearance; drawing together the surrounding

parts, and ultimately producing strange deformity. Thus, remarkable distortions of the face and neck (Fig. 102), or of the joints, are produced; and numerous remarkable deformities in all other parts of the body have not unfrequently been met with.

Tetanus, pyæmia, erysipelas, and other affections may be omitted in estimating the causes of death as from burn; they being, rather, accidental concomitants.

FIG. 102.



The *period of death* varies. The most fatal period is, perhaps, the first week after the accident. Erichsen found that in 50 fatal cases, 33 terminated before the eighth day; 27 of these dying before the fourth day. Of the remaining 17 cases, 8 died in the second week, 2 in the third, 2 in the fourth, 4 in the fifth, and 1 in the sixth week.

Prognosis.—The chief considerations which determine the prognosis of burns and scalds, are the more or less superficial character of the lesion and its extent, its situation, duration of the cause, and the age of the patient. The first two of these indications were sufficiently noticed in connection with diagnosis; a *superficial* but *extensive* burn is far more unfavourable than a deeper and limited one. Hence, many scalds are more fatal than burns. These indications, however, have reference to death principally by shock or congestion, in the first period, after burn; or by reaction and inflammation, in the second period. The *depth* of a burn—as compared with a scald—is significant with reference to suppuration and exhaustion, terminating fatally, in the third period. Deep burns are also unpropitious with regard to the part affected; distortion and loss of function supervening.

The *situation* of a burn more especially indicates the probability of visceral congestion. Thus, burns on the chest or abdomen are especially dangerous, in relation to congestion of the lungs or gastro-intestinal mucous membrane, respectively. Burns of the scalp are not

so ominous of cerebral congestion; but they are specially unfavourable as regards the liability to erysipelas. The *duration* of the burning cause is, perhaps, favourable, as to the less liability of internal congestion or inflammation ensuing, but unfavourable so far as it implies a considerable depth of burn and consequent exhaustive discharge. *Age* has scarcely any relation specially to the prognosis of burns. Children are peculiarly liable to the danger of (secondary) visceral affections, cerebral, thoracic, and abdominal; and more easily succumb to their influence than adults. Extreme age is, of course, always comparatively unable to resist the shock, and consequences of injury.

Treatment.—(1.) *Shock* and the tendency to *Congestion* require immediate attention. Wine, brandy, or ammonia are the stimulants commonly administered to induce reaction. Warm tea may be sufficient, if the patient be young and the burn slight. Laudanum, in favour with some Surgeons, is, I think, undesirable, as being conducive to congestion. The patient should be wrapped in a warm blanket; or immersion in a warm bath has been recommended, which also cleanses the surface of any charred portion of the clothes. (2.) *Reaction*, occasionally excessive, must be moderated by any gentle depletory measures, otherwise than by loss of blood. Mild purgatives, and the withdrawal of stimulants for a time, will generally reduce any undue reaction, as measured by the pulse and heat of the skin. It should ever be remembered that any temporary tendency to *inflammatory* symptoms readily subsides into a congestive tendency, affecting the internal organs. (3.) *Suppuration* and *exhaustion* are specially inevitable in the course of deeper burns; although some exhaustion supervenes in all burns. The strength of the circulation should therefore be retained for this period, and maintained when it arrives. Stimulants are again required, with tonics, and the generous diet suitable in cases of profuse and prolonged suppurative discharge arising from any cause.

Local Treatment.—The primary indication is to protect the surface from exposure to the action of the air. Increased and continued pain and shock will thus be prevented. For this purpose, various topical applications have been employed.

The degree or depth of burn will, I think, best determine the choice. *Erythema*, or vesication, cannot require any application more than simply protective. Collodion, mixed with castor oil, two parts to one, may be brushed lightly over the surface; or gutta-percha collodion, undiluted, may be used. Two or three coatings will perhaps be necessary. Some tingling pain, which aggravates the burning sensation, soon passes off. "Carron oil," consisting of equal parts of linseed oil and lime water, also answers admirably. Lint, dipped in this thick, yellow, pultaceous fluid, forms a covering, at once exclusive of atmospheric influence and emollient. *Deeper* burns, destroying the cuticle, skin, and so forth, thus presenting an exuding surface, are perhaps more advantageously covered with some absorbent material. Flour, dredged over the surface, soon forms an encrusting artificial skin. This need not be removed until loosened by increasing discharge and separation of the eschar. The removal of this crust by the Surgeon would be attended with great pain, and damage to the surface about to heal, and would aggravate the constitutional disturbance. But the possibly irritating character of this kind of dressing, and the impossibility of removing it, without these evil consequences,

are serious objections to any such application. Cotton wadding wrapped around the part forms a good protective covering, and aids in restoring the temperature of the part, a consideration of importance in proportion to the extent of surface involved; but this appliance alone is objectionable for the same reason as the flour-dressing. Carron-oil dressing, enclosed with cotton wool, will generally be found the best application. If the burn be extensive, one limb or part should be dressed at a time; while the remainder of the body is still covered up.

The *ulcer* formed by the detachment of the eschar, must be treated agreeably to the general directions already given with regard to Ulcers. Water-dressing, or a weak solution of nitrate of silver, will then be appropriate, according to the state of the granulations. Pencilling the marginal granulations with nitrate of silver or sulphate of copper, may be necessary, to repress their exuberant growth, and favour cicatrization. No dressing, in the whole course of treatment, should be reapplied unnecessarily; its removal being attended with great pain, and much increasing the constitutional disturbance. One of my earliest recollections as a student, was that of witnessing the shrieking of a patient during the dressing of a large burn over the thorax and abdomen, the muscles quivering and bleating by exposure to the air.

Contraction of the cicatrix is the grand difficulty to be prevented or overcome. In anticipation of this event, Dupuytren recommended attention to position and the application of extension by counteracting mechanical contrivances, as soon as the eschar had become detached and during cicatrization. But any such adjustment of splints and bandages or other apparatus, will generally prove effectual only for a time; the cicatrix contracting when left free, and at length presenting its usual appearance and the accompanying deformities.

Billroth recommends extension, with continued pressure, by means of a compress on the cicatrix; thus promoting the natural tendency of the contractile tissue to become atrophied, as in the treatment of strictured urethra by gradual dilatation.

Operations are practised with the view of overcoming contraction. *Division* of the cicatrix has often been tried, but with little permanent success. Complete division is necessary, both as regards the extent and depth of the cicatrix; any subjacent bridles must also be freely divided. All contraction having been thus overcome, extension should be maintained mechanically during granulation and cicatrization in the lines of incision. With every precaution, however, the new intervening cicatrix-tissue is apt to acquire the same evil disposition. I have had recourse to this operation in many cases, and repeatedly in the same case; but with no more successful results than in the hands of other Surgeons.

Removal of the cicatrix offers the advantage of getting into healthy or non-contractile tissue; but the extent of surface, or the part affected, may render this kind of operation impracticable. Thus, the cicatrix can be *excised*, when of limited extent, as in the form of a contracted band. Or, *destruction* by sloughing may sometimes be resorted to; this mode of removal being effected by means of a *clamp-instrument*, and which is especially eligible when the cicatrix presents in the form of a web, thin, and perhaps extensive. In the management

of webbed fingers, for example, the clamp is applicable. It was introduced by Brodhurst in 1861, and has since been employed by Tamplin, W. Adams, and other Surgeons with successful results. In aid of either mode of dealing with the cicatrix, *tenotomy* may prove serviceable when tendons are involved. Another method of treatment consists in the *transplantation*, or perhaps the *sliding*, of a flap of healthy skin into the gap made by division and extension of the cicatrix, or the surface formed by excision. Very happy results have been attained by Teale, Mütter, and James in thus overcoming the deformity occasioned by burns of the face and neck. Eversion of the lower lip into the chin, a disfigurement attended with slobbering peculiarly revolting, may be remedied by Teale's operation. The everted lip is divided into three equal parts, by two vertical incisions, each three-quarters of an inch in length, and carried down to the bone. These incisions are so placed that the middle or intervening portion occupies one-half of the lip. From the lower end of either incision, another is carried upwards to a point one inch above the angle of the mouth. The two flaps, thus indicated, are freely and deeply dissected up. The alveolar margin of the median portion is then pared. The lateral flaps are raised, united by twisted sutures in the middle line, and supported as on a base by the median flap, to which they are also attached by a few points of suture, leaving a triangular even surface to granulate. Gradual extension of the cicatrix from the sternum, and elevation of the chin, can be accomplished by means of a screw collar devised by Mr. James. *Skin-grafting*, according to the method of M. Reverdin, offers another resource—after division of the cicatrix, with extension—when the exposed surface has assumed the condition of a healthy granulating ulcer.

Diseased conditions of the cicatrix have received sufficient attention in this work, among Morbid Cicatrices, in general. Erichsen notices particularly a projecting red and glazed cicatrix, looking as if composed of a mass of fungating granulations smoothed down and lightly skinned over. This warty cicatrix—observable after burns about the neck and chest, more especially—resembles cheloid growth, but is remarkable as being the seat of intolerable itching, not relieved by any external application. Large doses of liquor potassæ mitigate this distressing symptom. But, if small and narrow, the cicatrix may be dissected out; if large, it does not admit of removal without risk of considerable hæmorrhage, as the structure, though fibroid, is very vascular.

Amputation is an operative resource unavoidable in certain external cases. Complete destruction, by charring, of the whole substance of a limb leaves no alternative; or, as a secondary operation, it may become advisable under circumstances, locally and constitutionally, analogous to those resulting from other forms of injury.

Lightning produces effects in the direction of its course through the part struck, resembling the appearances of any ordinary burn; but the shock may suspend the functions of the nervous system, partially or generally, without any marked appearances of burn, and may thus also kill instantaneously.

A *stroke* of lightning affecting the brain, knocks down the individual with loss of consciousness; lasting from a few minutes to a longer period, in one case an hour and a quarter. Recovery shows

that paralysis was suddenly produced, partially or completely; and this state may continue for an indefinite period. The special senses are variously affected; loss of sight, smell, hearing, and taste; or, more rarely, exaltation or perversion of these functions have occurred. Hæmorrhage from the mouth, nose, or ears sometimes happens; and abortion in some cases. A remarkable effect is said to be produced occasionally; the formation of an image, as if photographic, of neighbouring objects on the body, even on parts covered with clothes.

Every degree of *burn* may be produced, and perhaps in the same person, from the slightest singeing of the hair, reddening or blistering of the skin, to the deepest charring. The course of lightning through the body is sometimes marked by reddish-brown lines on the surface, having a starred and radiated appearance. In any case, the clothes are more or less rent and burnt. Other incidental injuries have been found, but rarely; such as wound, or fracture, particularly of the skull. The tongue was mutilated in four out of six cases of injury recorded by M. Bondin.

The *prognosis*, guided by the same considerations as with regard to Burns, is generally more favourable respecting the local lesion, which is often comparatively trivial, and also in respect to shock. But the subsequent paralysis or other functional disturbance may be a specially unfavourable condition, as consequent on a stroke of lightning not immediately fatal. Some persons seem to have *premonitory* symptoms of the approach of a thunderstorm. One such individual, within my own knowledge, a remarkably robust young man, is invariably troubled with extreme nervousness, headache, and an indescribable dread, compelling him to go to bed some hours before any apparent approach of a storm. How far this might be an unfavourable state of the nervous system is unknown.

After death by lightning, certain appearances are worthy of notice. The attitude of the body may be that in which it was when struck, or the body may be thrown to some distance from the spot. Rigor mortis, occasionally absent, is commonly present, and well marked, or even to an intense degree of rigidity, resembling the condition of a person frozen to death. The blood, sometimes coagulated, is usually singularly fluid, and continues in this state. Decomposition is sometimes speedy, but often delayed. The clothes are generally burnt or rent, even when the body is intact.

The *Treatment* of suspended animation from a stroke of lightning consists in artificial respiration, with warmth and stimulants to restore the circulation.

Frost-Bite.—Cold, intense or long continued, produces effects analagous to those of heat. It may kill the part directly, a local destruction analagous to charring, and accompanied with depression of the nervous and vascular systems, analogous to shock; or the part dies by the speedy supervention of gangrenous inflammation, a process of destruction accompanied with inflammatory reaction as the constitutional disturbance. Unlike heat, cold more frequently kills by its direct operation; presenting the condition known as frost-bite. This local effect, moreover, frequently exceeds in importance the general depression of the system. The parts most liable to be frozen are the feet and hands, or the ears and end of the nose, which are most prominent and exposed to cold. But the cold which can be borne with

impunity may be many degrees below zero, when the air is dry and still; a cold atmosphere with moisture or the slightest wind will speedily freeze a part exposed thus to a further and sudden reduction of temperature.

The *symptoms* of frost-bite are loss of sensation and power of motion in a muscular part; and, the circulation becoming arrested, a remarkable pallor overspreads the surface, deadening into a stone colour, with stiffness increasing to hardness, and even brittleness of the part, when quite dead.

The *constitutional* disturbance arises principally from general exposure of the body to cold, under the circumstances of frost-bite. Languor, and an overpowering sleepiness, ending in stupor or coma, invariably supervene during prolonged exposure to severe cold, and may thus cause death, the part itself dying with the general failure of life. The whole body becomes frozen by more continued exposure, and thence the condition known as "frozen to death."

A part frozen or frost-bitten is not irrecoverably *dead*. A whole limb may have become perfectly insensible and cold as ice, white and transparent like marble, incapable of being bent without breaking; and yet not absolutely dead. The combs of cocks and the ears of rabbits were frozen by Hunter, but these parts afterwards recovered. Leeches and frogs have been placed in the same state, and then restored to life. Cold-blooded animals, and parts of warm-blooded animals, when frozen, are, therefore, not dead, but asleep as it were, and can be aroused; even as a seed is ready to sprout, awaiting circumstances favourable to life. How *long* a frozen part may retain its susceptibility of life is uncertain; but this is certain, that, unless reaction be gradual, the returning flow of blood is apt to become excessive—to pass into inflammation, speedily ending in gangrene. While, therefore, gradual and moderate elevation of temperature induces salutary reaction and restoration, sudden or immoderate accession of warmth will inevitably excite gangrenous inflammation. When extensive, as in both feet, death may ensue from exhaustion, or from pyæmic infection.

Treatment.—In the dormant state of any part of the body from frost-bite, when although apparently dead the part is recoverable, pathology suggests the solicitation of reaction short of inflammation; and thence the prevention of gangrene, with loss of the part.

Restorative reaction can only be accomplished by the moderate and gradual application of warmth. Friction with something of nearly the same temperature as the frozen parts, fulfils this twofold indication; and thus, rubbing the part with snow is a practice both surgical as well as popular. A tingling or burning pain, and purplish redness, announce the returning circulation and tendency to inflammation.

Gangrene having supervened, the separation of the slough should be left to Nature; any unnecessary interference would give a fresh start to the process of destruction, in textures reduced to a low state of vitality.

Amputation may become necessary, as after a burn; the operation being performed also in point of time and situation, after the formation of the line of demarcation and above it. Yet there may be cases where the apprehension of fatal exhaustion, or of pyæmia, would warrant amputation at an earlier period.

CHAPTER XXI.

CELLULITIS. CARBUNCLE, AND BOIL.

Certain Blood diseases are declared by local inflammations of the subcutaneous cellular texture.

Cellulitis.—*Structural Condition.*—The textural changes wrought by this inflammation are these :—Speedily an effusion of serum engorges the subcutaneous tissue; this being soon exchanged for a purulent, bloody, sanious fluid. The cellular membrane dies rapidly, appearing in the form of shreds and skeins, and as mats of wet tow, or like large wads of wet shammy-leather; extending over a whole arm, a whole side, or over both successively. An immense extent, therefore, of cellular texture is sacrificed, and this widespread subcutaneous slough passes in between the neighbouring muscles; but the fasciæ are singularly spared; thus, the tendinous septæ between the ribs are seen bared in places where the muscular substance itself and other textures have disappeared. This process of destruction probably involves the skin, and to a corresponding extent. Vesicles or bullæ seldom appear until the subcutaneous inflammation is very far advanced. These vesicles are in general solitary, sometimes remote from the cellular disease, of considerable size, and occasionally filled with bloody serum. The existence of cellulitis, as an independent disease, has been doubted. I have seen at least one well-marked case. A girl had a trifling puncture, skin-deep, on the outer side of the right knee, which soon healed; yet inflammation of the subcutaneous cellular texture there commenced, and spread up to the hip, attended with diffuse suppuration and sloughing, so that the patient's life was in jeopardy. But the skin remained unaffected. By timely incisions, the case took a turn to slow recovery.

Symptoms, and Diagnosis.—Cellulitis might be mistaken for erysipelas. The swelling is not unlike, in both diffuse and œdematous. But the pain is at once the earliest and most distinctive symptom; it is excruciating. This, without perhaps any, even the slightest, blush of redness, is characteristic of cellulitis. And should the skin become involved, the cutaneous inflammation is always *secondary*, in all cases of true cellulitis; by advance from below upwards, from the cellular texture to the skin. This latter texture remains uninflamed, or is not primarily and essentially affected.

Fever.—The fever which precedes and accompanies cellulitis, aids but little to establish an early and exact diagnosis. In those cases which Duncan observed, this fever had so much of the typhoid type, that it was scarcely possible to foresee which disease would be eventually declared. Nevertheless, the fever presented considerable varieties in respect of its symptoms and progress. It sometimes commenced insidiously, sometimes turbulently, but in most of the severe cases soon reached its height. Its chief peculiarities were the supine position with depressed shoulders, in which attitude the patient almost always lay, without turning to either side, the absence of coma, and the rare

occurrence of delirium. The respiration was often remarkably embarrassed, owing to the inspiratory muscles—pectorals, intercostals, etc.—being the seat of cellulitis. In some cases, dyspnœa was rendered more urgent by pleurisy. In others, the respiration was itself much affected, especially when the disease began in the arm. Certain facts of apparently minor significance, because only occasional, are a peculiar cadaverous smell emitted from the patient's body during life, and that, in one case, a fœtid and coloured sweat proved critical.

Blood Origin.—Two facts at least point to the inference that cellulitis is the local manifestation of a blood-poison.

The fever being *typhoid*, resembles the working of some blood-poison analogous to that which is undoubtedly in operation when typhoid fever is engendered by infection; and the local manifestation itself—cellulitis being a spreading inflammation, extending continuously, and not confined to one spot, shows that some morbid condition of the blood disturbs the course of textural assimilation. The nature of the blood-poison demands investigation.

Treatment.—*Preventive* measures are unknown, nor can they be discovered until the etiology of this disease is better understood. The *remedial* treatment, so far as art has any controlling influence, is substantially the same, both constitutionally and locally, as for phlegmonous erysipelas.

Carbuncle and Boil are alike, essentially, inflammations of the subcutaneous cellular texture, which may occur in various parts of the body; but the effusion is *circumscribed* and brawny, so that the imprisoned cellular tissue invariably sloughs. Certain differences, however, will be observed.

Carbuncle or Anthrax.—Commencing as a hard, vesicular or pustular nodule, this soon enlarges into a flat, oval or circular, somewhat spongy swelling, having a brawny circumscribed border; the whole swelling being of a dusky, reddish-brown colour, and very painful,—burning, contracting, or throbbing. The size of this swelling varies from half a crown to that of a dinner-plate, and it varies also with the progress of the inflammation. At length the skin over the flat surface yields in yellow or ash-coloured sloughs at numerous points, forming as many small apertures, through which a greyish or yellowish, sloughy and purulent, fœtid discharge oozes, or starts up on the slightest pressure around; exhibiting a cribriform appearance never to be forgotten when once seen, peculiar to carbuncle. As sloughing of the skin advances, the apertures run together and coalesce, the cribriform surface disappears, and discloses the subjacent cellular texture, a quagmire of slough. Carbuncle is commonly situated about the shoulders or on the nape of the neck, where if large it gives a remarkable breadth to that part. Occurring sometimes on the lower part of the back or sacrum, it may form on the front of the chest or abdomen, occasionally on either extremity, and very rarely on the forehead or face. One on the nose, seen by Sir B. Brodie, gave the most singularly hideous appearance, completely disguising any lineaments of the human face. Fortunately, carbuncle is usually solitary.

Fever of the typhoid character precedes and accompanies the swelling, and it becomes more marked as sloughing ensues. But there is also a notable derangement of the liver and other digestive organs, indicated by a yellowish complexion and brown furred tongue.

The *causes* of carbuncle are, as to their essential or pathological nature, obscure. It is a disease of advanced years, or it appears in those whose constitution has broken down prematurely. It is also induced by habitual free living, without exercise. It is associated, not unfrequently, with diabetes mellitus or albuminuria; and swellings of a carbuncular character are not uncommon in some infectious diseases, as typhus and typhoid fevers, and plague.

Course and Terminations.—Generally, the slough of cellular texture having been thrown off or removed, the cavity, often of considerable size, slowly heals by suppurative granulation; and the patient's health is ultimately regained, a marked improvement having taken place when the slough was detached. But the brawny induration remains for some time, and a puckered cicatrix permanently. Sometimes, however, the sloughing deepens as well as enlarging superficially; and involving important parts beneath, or overwhelming with prostration, thus proves fatal. A large carbuncle situated on the nape of the neck is especially perilous. Rarely, a carbuncle subsides suddenly, and the person rapidly sinks, death occurring apparently from septicæmia. Carbuncle on the face is apt to speedily induce meningitis, attended with delirium, and death results from effusion in three or four days; a case or two of this kind having happened in Billroth's practice.

The *prognosis*, in different cases, will be guided by the foregoing considerations.

Treatment.—*Preventive* measures are said to be occasionally successful. In the earliest stage of the disease, while yet only "a small pointed vesicle on a hard, brawny base," observes Mr. Erichsen, its further progress may often be completely arrested by opening the vesicle and rubbing its interior with a pointed stick of potassa cum calce or nitrate of silver. Later still, he has often seen the extension of a carbuncle prevented, and a cure effected, by covering it with a square of soap-plaster spread on thick leather, with a hole in the centre for the exit of discharge. I have had no experience of a carbuncle in this stage, nor of the preventive treatment accordingly. In considering the appropriate *curative* treatment, the preservation of as much integument as possible, by the limitation of sloughing, with the relief of pain and constitutional disturbance, are primarily important; and the discharge of slough subsequently is equally so. Early relief of tension fulfils the former indications, an outlet fulfils the latter. Timely, free incisions fulfil both. A *crucial* incision, carried through the slough and the surrounding induration, as Sir B. Brodie recommended, answers admirably. The *period* for making this double incision must be determined by due observance of both the purposes in view; always inclining to the consideration of relieving tension. A free application of *potassa fusa*, after the bistoury, was advocated by the late Professor Miller, in order to at once form an eschar and thus limit sloughing. Poulticing until the slough is discharged, with the use of carbolic, chlorinated, or other antiseptic solutions, and then dressing according to the state of the ulcer, are the only applications ordinarily required. *Subcutaneous* section, as proposed by Mr. French, is another method of treatment, on the same principle; the mass being divided crucially, or in various directions, in order thus to facilitate sloughing and discharge through the openings in the integument. A poultice is applied for this purpose. On the

other hand, *compression* has been advocated, in the direction from the circumference to the centre of the carbuncle; a layer of soap-plaster on leather, having a central aperture, is applied, and then cross-strips of adhesive strapping. Lastly, non-interference is recommended by some Surgeons of experience, as a general rule, and especially by Sir James Paget. In his highly suggestive "Clinical Lectures and Essays," so many valuable observations are urged, and so persuasively, to show the inutility or positive harm of any active treatment generally, that I should at once perhaps be converted from the error of my ways, if only I had seen as many illustrative cases.

The constitutional treatment, medicinal and dietetic, much resembles that of phlegmonous erysipelas. Early recourse to stimulants, tonics, and a generous diet; but with special attention to the state of the liver and digestive organs. Yet here we encounter the chief difficulties. Inappetency, nausea or actual sickness, and mal-assimilation, all conspire to defeat our alterative mercurials and effervescing salines, as well as our endeavours to coax the stomach with digestible and nourishing food. If any other disease, to wit, diabetes or albuminuria, be associated with carbuncle, such complication will further embarrass the treatment. According to Sir James Paget's large experience, comprising not less than two hundred cases of carbuncle, the constitutional treatment requisite is very simple: no special recourse to stimulants and tonics, with a supporting diet; but principally fresh air, without confinement to bed, and opiates to procure sleep or allay pain. Cerebral symptoms, arising from facial carbuncle, must be met by the application of ice or cold lotions to the head, and mild constitutional measures repressive of inflammation. The mortality of ordinary carbuncle is about two per cent; a lower death-rate than in perhaps any other disease of equal extent and severity.

Boil or Furunculus.—In some of its external characters, Boil contrasts with Carbuncle. It is an inflammatory swelling, of a *conical* shape, softening as it maturates, but set in a hard base; of a purplish-red colour, and exquisitely painful and sensitive. Its *size* is much more moderate than carbuncle, never perhaps exceeding the smallest swelling of that kind, about half a crown. Its smaller size and conical shape are diagnostic, even in an early stage. Enlarging slowly, matter forms at the apex of the cone, tipping it with a yellow colour; this point bursts and discloses a subjacent slough or core of cellular texture. But the cribriform, flat surface of carbuncle is never seen,—another diagnostic difference. Like carbuncle, a boil is commonly situated where the skin is thickest; on the back of the neck, the shoulders, or the buttock, the latter being a favourite spot of election; occasionally in the armpit, or on the thigh. They always seem to choose the most troublesome situations. To increase the torment, they seldom come singly, but are gregarious or successive.

Feverishness, generally of a more sthenic character than with carbuncle, accompanies the formation of boils.

The *causes* also, so far as they are known, somewhat differ from those of carbuncle. Usually occurring in earlier life, boils are also connected with a plethoric state of the system; but they may denote an enfeebled condition, or they may appear in the sequel of febrile diseases. Their fitful character is often far less explicable. Active exercise by persons of sedentary habits, sea-bathing, the spring-time of

the year, or some epidemic influence, will, perhaps, severally suffice to bring out a crop of boils.

The *treatment* is that of carbuncle on a small scale. A poultice or warm fomentation, to promote suppuration and detachment of the slough, should be followed, if the latter does not take place, by a sufficient incision for expulsion of the core without any thumbing or squeezing. With water-dressing, the little granulating wound will then look after itself.

Constitutional measures must have reference either to the plethoric or debilitated state of the system. Alterative mercurials and saline aperients, followed by liquor potassæ and other alkaline treatment; or quina, iron, and nitro-muriatic acid, the acid-tonic treatment. At the same time, a well-regulated diet, and state of the digestive process, must not be overlooked; in weakly patients, the assimilation of nutritious food being promoted by a course of cod-liver oil.

Chilblain.—This is a local inflammation of the skin, of an asthenic type; and subject, sometimes, to regular recurring attacks of congestion. It occurs in three degrees :—(1) Simple congestion, attended by great itching, alternating with periods of extreme tenderness to external pressure; (2) in the form of vesication; (3) death or sloughing of the affected portion of skin, and perhaps of the subcellular tissue, forming an ulcer of an indolent character.

The *Symptoms* of chilblain are obvious, in connection with each of these forms of this affection. Congestive purplish redness, with a tingling, itching, or burning heat or pain, which comes and goes, and some degree of swelling which has a shiny appearance. Recurrence of the symptoms seems to be determined by circumstances affecting the circulation, as exposure of the part to the warmth of a fire, or of a periodic character, as the stimulant effects of daily meals. The vesicated and ulcerated forms of chilblain present appearances which are sufficiently indicated by these terms. Certain parts of the body are most commonly affected; the feet, hands, or both; more rarely, the lobes of the ears, or even the end of the nose.

The *causes* of this affection may be said to be, sudden variations in the external temperature, and in connection with the predisposing condition of a weak circulation. Hence, chilblain is liable to occur in persons of the leucophlegmatic temperament, or of a scrofulous constitution. Age has decidedly some influence; it happens most frequently in young persons or children, and of both sexes; and in adult females more often than in men. This liability generally passes off towards manhood; and chilblains are rarely met with in men over forty years of age, though in weakly women they may recur throughout life. Local causes affecting the free circulation in the part, should not be overlooked; such as tight gloves, elastic bracelets and garters, or tight shoes, and the sitting posture, long continued, in cold rooms, and with the legs pendant,—as in the mistaken discipline of many a schoolroom.

Treatment.—Preventive measures will consist in promoting the general circulation; by an even temperature, particularly as regards sleeping and sitting rooms in cold weather, warm under-clothing, socks and gloves, with regular exercise; and the removal of any restraint to the circulation in the exposed parts of the body. A generous diet, with small stimulant doses of opium and quinine, may likewise prove salutary. In the event of any chill, affecting particularly the feet

and hands, the circulation should be restored very gradually, by friction and warmth. *Curative* treatment must depend on the state of the part. When chilblains are unbroken, the congestive inflammation may be brought to resolution, by daily frictions with stimulating embrocations, as of camphor or tincture of iodine, and soap liniment. The old-fashioned remedy, brandy and salt, should not be despised. Intolerable itching sometimes admits of relief by lead-lotion, or opiate ointment. Vesicated chilblains may be protected by a coating of collodion and castor-oil varnish. Ulcerated chilblain must be treated by poulticing rendered stimulating by admixture with spirits of wine, or turpentine, until any slough separates; and then the dressing may be resin ointment, or other topical applications, as for any other weak or indolent ulcer.

WHITLOW or PARONYCHIA.—An asthenic inflammation of the dense fibro-cellular tissue forming the pulp of the finger or thumb; this part becomes acutely painful, tense and hard, swollen so as to give a globular appearance to the end of the finger, and of a reddish colour. The inflammation and swelling are always diffuse—unlike phlegmon; and it tends also to suppuration and sloughing of the cellular texture, thus also differing in its termination. (Fig. 103.) Necrosis of the ungual phalanx is not an uncommon event, in prolonged cases. Whitlow occurs spontaneously in persons of a naturally weak or of a debilitated constitution, affecting both young and old, and either sex. Occasionally, it seems to have an epidemic character, appearing in many persons without any traumatic cause; and perhaps at certain seasons, as in the spring. But it arises frequently from some local irritation, as a puncture, scratch, or inoculation with some poisonous matter. Hence, it is more frequently met with in connection with certain occupations, as in cooks, washerwomen, and grooms.

FIG. 103.

Whitlow, involving the *sheath of the tendons*, is a more severe form of this affection. It is attended with greater swelling of the whole finger, spreading to the hand, which becomes much puffed and enlarged. Violent throbbing in the finger, and shooting pain up the arm, are soon experienced; but the redness is not intense, and the end of the finger, particularly if the cuticle be thick, and the palm of the hand hardened by work, may assume a dull-white appearance—soddened, perhaps, by poulticing. Some inflammation of the lymphatics, denoted by red lines extending up the arm, not unfrequently accompanies this form of whitlow, and with much low feverishness or constitutional disturbance. Diffuse suppuration takes place in the sheath of the tendons, speedily involving the palm, and may even spread up the forearm, under the annular ligament. The swelling has an elastic character, but distinct fluctuation is obscure. Sloughing ensues, not only of the cellular texture of the finger and hand, but also of the tendons and palmar fascia. Necrosis of the phalanges results; or a matted state of the part, with a rigid and contracted state of the finger and perhaps of the palm, rendering the hand useless.

Treatment.—An incipient whitlow may sometimes be subdued by the prompt employment of repressive measures; by leeching, poulticing, and an elevated position of the hand. In the *simple* form of whitlow, a crucial incision into the pointed swelling of the pulp of the finger, should be made at an early period; or even snipping the vesicated summit will give great relief. In the *tendinous* form of whitlow, an early and free longitudinal incision, in the middle line of the finger, must be had recourse to, for the relief of tension and swelling. The digital arteries and nerves are thus avoided, and the sheaths of the tendons should not be opened extensively, thus to prevent sloughing and consequent rigidity of the finger. Suppuration or abscess in the palm must also be relieved by timely incision, observing not to wound the superficial palmar arch, which about corresponds with the middle indentation across the skin of the palm. Then well soak the finger and hand in warm water, and envelop the whole with a poultice. The nail, growing and elongating, appears large; it often loosens, and should then be removed by evulsion with a small pair of sequestrum-forceps, or with Hilton's nail-forceps, which holds more firmly and with less damage to the matrix. As a foreign body, the nail would be a source of continued irritation. Any adherent portion need not be removed, but may be pared and scraped to relieve tension. A new nail will form, if the matrix be healthy; probably taking a period of five or six months before it is completely restored. In tendinous whitlow, when the inflammation has subsided, a pasteboard splint will be advisable, to prevent contraction.

Necrosis of the ungual phalanx necessitates the extraction of this dead portion of bone; leaving the pulp end of the finger and nail, which eventually form a somewhat hooked extremity, tolerably sensitive and useful, and not so unsightly as a truncated end. Amputation will be unavoidable, in the event of more extensive destruction, involving the middle or the first phalanx. And it is better to operate rather, apparently, too high, than too low for the sake of preserving the useless remnant of a finger; any portion of the thumb, however, will be most useful. The general health must be renovated by tonics and diet.

Fig. 104.

Onychia is a form of ulceration, which commences about the matrix of the finger-nails. It usually arises from a pinch or crush of the finger end, bruising the matrix or loosening the attachment of the nail. Shortly after this injury, the finger-end swells, and fluid is effused beneath the nail, which loses its natural colour, and becomes thin and flattened at the end, or more rarely curled up laterally. As the nail continues to grow, it turns upward, and exposes beneath it a very foul, fœtid, and painful ulcer; while the finger-end becomes enlarged and bulbous, the integument hardened, shining, and of a livid red colour. (Fig. 104.) This affection occurs mostly, according to Mr. Thomas Smith's observations, in children under ten years of age; but is by no means common. It is little prone to spontaneous recovery; proceeding, perhaps, to necrosis of the ungual phalanx.

The disease is sometimes named onychia *maligna*, as a *specific* ulceration.

Treatment is, firstly, evulsion of the nail; and this is accomplished either by tearing it off as a whole, by seizing it with a strong, narrow-bladed pair of sequestrum-forceps, or with Hilton's instrument; or, by dividing the nail with a narrow-bladed pair of scissors, run up to the root of the nail, and then everting each half with the forceps. Both scissors and forceps must be applied with a firm hand. Local anæsthesia will suffice to completely deaden sensibility, the pain otherwise being excruciating. Pounded ice and salt mixed in a bladder is convenient for this purpose, or Dr. Richardson's ether spray answers equally well. Water-dressing or carbolic lotion may then be followed by arsenical solution, one or two drachms of the liquor potassæ arsenicalis to an ounce of water. Chlorate of potash and tonics, especially bark, complete the treatment.

Syphilitic onychia, as a secondary affection, has already been noticed.

In-grown Toe-nail.—This is a not uncommon condition, among especially the working-classes; it may occur on either side of the great toe-nail, but more frequently on the outer side. It is attended with considerable pain in walking, and gives rise to fungoid and sensitive granulations, overspreading and concealing the in-growth, accompanied with a thin, fœtid discharge. This condition is caused, apparently, either by overcrowding the toes in a narrow, hard boot, thereby thrusting the adjoining integuments over the side of the nail; or, by the toe-nail having been pared away too deeply at the side, thus allowing the integument to overlap; in either way the nail grows into and includes itself in the overhanging fold of integument. *Treatment* consists in removing any cause of pressure, as a tight or hard-toed boot, and then endeavouring to correct the faulty growth of the nail. The pressure of the integument on the nail may be relieved by neatly inserting shreds of oiled cotton wool into the cleft by means of a probe or the back of a scalpel-blade. Then, when sufficiently separated, in the course of some days, the margin of the nail can be gradually raised in like manner, until the natural state of the part is restored. Scraping the edge of the nail very thin sometimes affords sufficient relief; or, by notching the free edge down to the matrix, the strip of nail as it grows, may gradually overlap the body of the nail, and thus bring relief. An obstinate or deep in-growth can only be cured by evulsion of the nail, as in the treatment of onychia. After any such mode of cure, the fungoid granulations subside, or they may be repressed by pencilling with nitrate of silver or sulphate of copper. Zinc ointment may be applied during the healing.

Corns.—Local hypertrophy of the cuticle forms the common corn; a flattened or conical swelling, hard or soft, often acutely painful—varying in this respect, according to pressure on the part, the state of the health, and even the weather. Such cuticular out-growths occur commonly on the feet, usually on the outer aspect of the end of the little toe; or between the toes, and then always as a soft corn, apparently from maceration of the cuticle by warmth and moisture. Occasionally, corns form on the hands, and more rarely over the prominences of the elbows or knees. They are produced by intermittent pressure or friction on some naturally prominent part, as on the little toe, by wearing a tight, hard boot. Eventually, beneath an old corn,

a bursa is apt to form, which, becoming inflamed from time to time by pressure, greatly aggravates the pain and inconvenience in walking. Suppuration is liable to ensue.

Treatment.—Relief is obtained by simply removing the cause of pressure—wearing a loose shoe or slipper, or protecting the corn by means of a circular plaster of thick leather, having a hole in the centre over the corn. The common "corn-plasters" are thus used. Pencilling with nitrate of silver induces desquamation, and thus thins down the corn. Paring or scraping down the corn, previously macerated in warm water, will also ease the pain, as occasion requires. Extraction of the centre or core of the corn is the ordinary practice of chiropodists. But the full-grown corn often returns. Inflammation and suppuration must be treated on ordinary principles.

Horns.—Remarkable forms of out-growth, consisting of fibrous or fibro-cellular texture, have been known to occur on various parts of the body, particularly the head or face; and springing from the various sebaceous cysts, unruptured, or ruptured spontaneously or by accident. Such a horny excrescence has a crooked, tapering form, and a yellowish-brown colour. It may be met with in middle age or advanced life, though very rarely. Similar kinds of out-growth may arise from the matrix of one of the toe-nails, especially the great toe; extending from one to four inches in length, tapering at the point, and curved spirally like a ram's horn. This is simply a vertical elevation of the epithelial layers forming the nail.

Excision completely from the base of the horn is the only cure.

Warts or Verrucæ are collections of overgrown cutaneous papillæ, either completely ensheathed by an excessive production of scaly epithelium, or with the papillæ isolated, each having only its own natural cuticular sheath. They may form in various parts of the body, a common situation being the hand and fingers. Warts may arise spontaneously, apparently, or be congenital, or perhaps hereditary; but usually they proceed from some source of local irritation, as dirt or discharge, or from the handling of animal matter, in cooking or dissection. They occur more often in children, and in girls who have the evil habit of masturbation, though the presence of warts on the hands should not alone beget an unworthy suspicion of such practice. Venereal warts, excrescences, or vegetations well illustrate the origin of warty growths from irritative discharge. Such and similar warts are undoubtedly contagious. Common warts come and go, sometimes, in an unaccountable manner.

Treatment.—Escharotics may succeed in removing these often obstinate out-growths. The strong acetic acid, applied by means of a glass-brush, or rod, is the most efficacious. Excision with the knife or curved scissors, is the only other mode of cure.

Morbid Growths.—Besides Warts and the other cutaneous out-growths already referred to, the skin may be the seat of tumours or morbid growths—*e.g.*, painful subcutaneous tubercle, nævus, epithelial cancer. (See Ch. II.)

Ulcers. (See Ch. IV.)

MUSCLES AND TENDONS.

CHAPTER XXII.

SPRAIN.—RUPTURE.—TUMOURS.

Sprains or Strains.—*Structural Condition, and Symptoms.*—Muscular and tendinous structures are liable to be suddenly stretched by violence, without any actual or perceptible rupture of fibre. This lesion commonly takes place in those muscles which are most apt to be brought into action by any sudden and violent exertion, as in running, leaping, dancing, or lifting a weight. Immediate pain and inability to use the part, followed by stiffness, are conclusive symptoms. Any degenerative change, or softening of the structure, will predispose to this kind of injury. It may be succeeded by atrophy and partial paralysis.

Treatment.—Rest is necessary for reparation, and this requisite is secured by the renewal of pain from any attempt to use the damaged muscle or tendon. Subsequently, friction and stimulant embrocations aid in overcoming the stiffness and removing any remaining thickening.

Rupture of Muscle and Tendon.—This lesion may be regarded as only a further degree of Sprain, but it presents certain additional particulars of importance.

The part of the muscle or tendon ruptured is in the muscular substance, or at the junction of the muscle and tendon, in the tendon, or at the junction of the tendon and bone. In twenty-one cases Sédillot found the rupture had occurred at the junction of the muscle and tendon in thirteen, but through the muscle in eight only. Occasionally, the sheath of the muscle or tendon is ruptured; a protrusion taking place through the aperture. This more frequently happens to the long head of the biceps muscle, or the extensor tendons of the fingers. The muscles most liable to sprain are also subject to rupture, by sudden and violent exertion. Hence the gastrocnemius, or its tendon; the quadriceps femoris, just above the patella, of which I have seen two instances; also the biceps or triceps of the arm, the former giving way above, in its long head, or below, at its insertion, the latter muscle or its tendon rupturing just above its insertion, into the olecranon. More rarely, the deltoid or the pectoral muscle yields, the rectus abdominis, or the muscles of the back are torn.

The *symptoms* are generally well marked; sudden pain and powerlessness, with a sensation as if something had given way, and perhaps an audible snap. Pain is far less acute if a tendon be the seat of lesion. An interval may be discovered in the situation of rupture, into which the finger will fall when passed over the surface; a hard swelling above and below is also felt, if a muscle be torn, the retracted ends rising up. Subsequently, this state of the part is obscured as inflammatory swelling supervenes, or reparative lymph occupies the

interval between the ruptured ends of muscle or tendon. Some discolouration may accompany the former change, or any extravasation of blood incident to the injury.

Causes.—Muscular contraction is the immediate cause of rupture far more frequently than external violence. Age predisposes, by reducing the elasticity of muscular texture in common with that of all textures. This lesion therefore, occurs most frequently in persons of middle life, and who are sometimes wont to undertake feats of sudden exertion beyond their strength, in running, jumping, dancing, or lifting a weight. Degenerative changes will also predispose; and thus the rectus abdominis muscle has been found to have undergone fatty degeneration in some cases of its rupture.

I am not aware of such predisposing conditions having been noticed in connection with the rupture of tendons.

Course, and Terminations.—(1.) *Reparation* ensues, and readily, in most cases. It has been traced by Paget and Adams in rabbits, and by the latter observer in the human subject. The process is the same essentially, and alike after subcutaneous division or rupture, as follows:—

Separation of the ruptured extremities of a *tendon*, *e.g.*, tendo-Achillis, takes place to a very variable extent; in an adult, from one to two inches; in an infant, about half an inch. The upper portion is drawn upwards by contraction of the muscle, and the lower portion is drawn downwards, according to the mobility of the ankle-joint and position of the foot. Similar circumstances limit the separation of the divided extremities of tendon in all cases. The separated ends still remain indirectly connected with each other through the medium of the cellular sheath of the tendon, which remains almost intact, as a tubular sheath. Blood, in very small quantity, is generally effused within the sheath, and adheres to the upper and lower extremity of the tendon, principally to the upper. But if the blood be in such quantity as to fill the sheath and infiltrate the surrounding tissues, reparation is retarded and rendered less perfect. Increased vascularity of the sheath marks the commencement of the true reparative process; this vascularity extending to the subcutaneous cellular tissue and fat. Reparative blastema is effused into the meshes of the cellular sheath, as a matrix, which thus becomes succulent, as well as vascular; the infiltration may also spread into the surrounding cellular texture, and obscure the gap in the divided tendon. This blastema is developed into fibres, through the medium of oval nuclei; unlike inflammatory lymph in open wounds, which is developed into fibres through nucleated cells, transition forms being found in the shape of elongated cell-fibres. The nucleated blastema would seem to undergo transition by elongation of the oval nuclei, and their arrangement in parallel linear series; presenting a fibrillated, and ultimately a more distinctly fibrous appearance, under the microscope. Capillary blood-vessels are formed in the connective tissue thus produced.

The divided ends of the old tendon take no active part whatever in the reparative process during its earlier stage, and have but slight connection with the new material when first formed. A little later, their square surfaces and sharp edges become somewhat rounded, and their substance somewhat softened. Enlarging, and evincing a disposition to split, thin streaks of new material, greyish and translucent, are

interposed, indicating the commencement of junction between the old and new tissues. The bulbous enlargement of the old tendon-ends, occasioned by the increasing interposition of new material, gradually subsides, until they regain their former appearance, and the new and old tendon become of uniform diameter. The appearance of fine dove-tailing long remains, being distinctly traceable a year and a half, and three years, after division of the tendon. Complete and firm junction of the new with the old tendon is established; a want of definition along the deep surface of the new tendon remaining, by adhesion between this surface of the tendon and the deep fascia. The process of reparation is completed by the re-formation of a separable sheath on the surface of the new tendon.

The new tendon, homogeneous rather than fibrous in appearance, is at first vascular and ruddy, but afterwards greyish and translucent; an appearance which contrasts with the old tendon, above and below, and which is retained up to the latest period of examination hitherto made in the human subject, three years after operation. Considerable toughness and strength are soon acquired; in the tendo-Achillis of a rabbit, six days after its division, a weight of 20lbs. was required to sever it, and after the lapse of ten days, the rupturing weight had increased to 56lbs. A linear cicatrix is supposed by Mr. Tamplin, and other observers, to be the ultimate remnant of the bond of union; but, according to Mr. Adams's observations, this appearance is deceptive, the connective tissue or new tendon remaining as a permanent bond during life. The greatest *length* of new tendon formed in the human subject is apparently, as Mr. Adams states, two inches and a quarter; and this was found in the tendo-Achillis of a girl, aged nine years, a year and a half after tenotomy.

Fig. 105.

Divided *muscles* undergo, essentially, the same process of reparation, union by a fibro-cellular bond.

Treatment.—Rest is of course requisite for union to take place; but attention to position by relaxation of the muscle or tendon, and the maintenance of that position, are equally necessary, the structure being not merely strained or stretched, but divided. These indications of treatment are well illustrated by the treatment of rupture of the *tendo-Achillis*. The leg is flexed, and the heel drawn up, by means of a band attached to the shoe behind, and fastened to a belt around the lower part of the thigh. (Fig. 105.) If the relaxed position be disregarded, the uniting bond will inevitably be elongated and weak. With this result, antagonistic muscles may afterwards occasion considerable deformity by their continued and inadequately opposed contraction Talipes varus, after operation and premature removal of the splint,

may thus become slowly converted into the opposite deformity—talipes valgus. Hence also the newly united muscle or tendon should be exercised very gradually and cautiously.

(2.) *Imperfect and non-union of Tendon.*—Various causes lead to these results.

Imperfect union of the tendo-Achillis, for example, may arise from some constitutional defect in the reparative powers of the individual, or from depressed vital power in the limb, owing to paralysis. Injudicious after-treatment may be followed by the same result; as from not sustaining the temperature of the limb, especially in paralytic cases during very cold weather; from too early and too rapid mechanical extension; or too early exercise of the part.

Non-union is specially apt to arise when tendons are situated in dense tubular sheaths; the divided ends of tendon becoming adherent to the inner surface of the sheath, but not having any direct connection with each other.

Treatment.—Any of the causes of imperfect, or non-union, must be avoided or corrected. With respect to mechanical extension, after operations for deformity; Mr. Adams does not consider it necessary to make extension gradually, for the purpose of stretching the new tendon, the requisite leugth of which should be obtained during the period occupied iu its formation, ordinarily two or three weeks; but gradual extension is necessary, either to overcome ligamentous resistance, or to prevent a too rapid and excessive separation of the divided ends, and thus regulate the length of new tendon produced. The liability to non-union may be avoided, by never dividing a tendon in its course through the denser portions of its sheath, and when the operation is performed near to such parts, exteusion should be conducted very gradually.

Certain operations have been practised to induce the reparation of an ununited teudon. Paring the ends and joining them by suture will seldom prove satisfactory. Subcutaneous puncture, as for ununited fracture, has proved successful in some cases.

Displacement of Tendon may occur. The tendon of the tibialis posticus muscle occasioually slips out of its groove, with iustant pain aud lameness. The long teudon of the biceps flexor cubiti is sometimes tilted out of its groove. Such mishaps geuerally rectify themselves, the tendon slippiug in again; or replacement can be readily accomplished by a little manipulation.

Inflammation of Muscle.—Myositis.—Rare as au idiopathic, and a primary disease, the muscles may be involved by the extension of inflammation from adjoiniug structures. Rheumatic inflammation of the muscles is probably of this kind, affecting primarily the investing aponeuroses. Syphilitic inflammatory indurations of muscle are also said to occur. Pyæmic abscesses occasionally form in the muscles. The interstitial cellular tissue is infiltrated with purulent matter, while the muscular fibres are disintegrated, and disappear, as abscess forms.

I once saw a notable instance of inflammatory extension; peritonitis had induced inflammation of the abdominal recti muscles, which, after death, presented a quagmire of slough and pus. Immediately behind the sheath of these muscles, and near the umbilicus, lay the vermiform appendix of the cæcum, which contained a bean. It was, apparently, a grand effort of Nature to discharge this impacted foreign body.

Traumatic inflammation may involve the muscular texture, in common with other tissues.

When myositis subsides, it leaves the muscle more or less stiffened and powerless, an affection which lasts perhaps for some time; and, in the event of suppuration, contraction is apt to result, as a more intractable state.

The *treatment* of muscular inflammation must be conducted on general principles, having reference to the apparent causes in operation. Abscess also requires no special notice.

Tumours of Muscle.—Equally rare, perhaps, as primary diseases, the muscles are yet sometimes the seat of Morbid Growths. The reader is referred to the situations of Morbid Growths, for some such particulars. But Mr. Teevan has collected 62 cases of tumours of muscles. About one-third were *cancerous;* 16 *fibrous;* 8 *cystic;* 5 *hydatid;* and 5 *erectile.* Mr. Erichson has seen 7 cases of tumours "primarily" formed in muscles. A *fibro-cystic* tumour, as large as a cocoa-nut, was "developed in connection with the tensor vaginæ muscle;" a cystic tumour, the size of a fœtal head, was produced in the substance of the adductor brevis of the thigh; a *fibro-plastic* tumour, the size of a child's head, formed within the sheath and in the substance of the sartorius muscle of the left thigh; another cystic tumour, about as large as a goose's egg, arose from the flexor brevis digitorum. *Encephaloid cancer* formed in the cicatrix, and springing from the muscle just named, showed the nature of the original tumour. In two cases, the tumours were *hydatid;* one in the deltoid, the other at the outer edge of the latissimus dorsi. In the seventh case, the tumour was an *enchondroma* in the tibialis anticus muscle. In one other case, enchondroma was situated in the vastus-externus; and in yet another, it was connected with the pectoral muscle.

The muscles of the lower limb are most frequently the seats of tumours; in the upper limb, according to Mr. Teevan, the muscles, usually, are the pectoralis major, deltoid, and biceps. Those of the neck and trunk are seldom diseased, excepting the rectus abdominis muscle, a frequent seat of tumours.

The *treatment* of muscular tumours differs in no way from that of the same growths situated in other parts of the body. Excision and amputation are the only known resources.

Degeneration of Muscles.—See General Pathology and Treatment of Degeneration.

BURSÆ AND SHEATHS OF TENDONS.

CHAPTER XXIII.

INFLAMMATION.—GANGLION.

BURSÆ MUCOSÆ. SYNOVIAL BURSÆ.—The bursæ are synovial sacs. resembling other synovial membranes, and differing only in situation. They are interposed between the surfaces of parts which naturally move on each other. Thus, they are situated, normally, as subcutaneous bursæ, in the cellular texture between the skin and some firm prominence—*e.g.*, the bursa over the patella; or deep-seated, between a muscle or its tendon and bone, or between two muscles or tendons, and not unfrequently communicating with a neighbouring joint. Subcutaneous bursæ may be adventitious, resulting from enlargement of the areolæ in the cellular texture by continued friction; as beneath corns, bunions, the prominent points of club-foot, and other exposed situations. Such bursæ are, however, imperfect; spaces being thus formed in the cellular texture, rather than bounded by any true synovial membrane.

Situations of Normal Bursæ.—In the following situations, bursæ exist naturally, and are subject, therefore, to injury or disease:—behind the angle of the lower jaw, on the symphysis of the chin, on the angle of the thyroid cartilage, on the acromion, between the lower end of the scapula and the latissimus dorsi, under the deltoid, on the external and internal condyles of the humerus, the olecranon, the styloid processes of the radius and ulna, on the metacarpo-phalangeal articulations, their dorsal and palmar surfaces, and on the dorsal aspect of the phalangeal articulations; on the anterior superior spine of the ilium, the great trochanter, the tuberosity of the ischium, and under the gluteus maximus, on the patella, on each condyle of the femur, the tuberosity of the tibia, in the ham, on the two malleoli of the tibia, the os calcis, the dorsal surface of the toes, and the plantar aspect of the heads of the first and fifth metatarsal bones.

(1.) BURSITIS.—INFLAMMATION of a bursal sac may occur, with enlargement and distension of the sac with synovial secretion. Suppuration soon follows, and the formation of abscess, which bursts externally or into the surrounding cellular membrane. This texture is also liable to become involved as the abscess progresses. The resulting ulcerations are singularly obstinate.

(2.) *Chronic enlargement* of a bursa, from long-continued pressure and irritation rather than inflammation, is another condition of common occurrence. The bursa becomes distended with contents of variable nature, partly fluid and solid; as an increased sero-synovial secretion of clear straw-coloured fluid, or a brownish fluid, thick and grumous, apparently due to altered blood, or adhesive and containing cholesterine. Fibrinous matter is sometimes deposited on the interior

of the sac, gradually producing considerable thickening of the wall of the bursa. Within the sac, numerous small flattened and elongated bodies may form, resembling melon-seeds or parboiled rice; and which result, apparently, from disintegrated fibrinous matter subjected to motion and attrition, or from the detachment of pedunculated fibrinous matter from the interior of the sac. The origin and production of these bodies are thus similar to the formation of loose cartilages in joints, and they gradually acquire a fibro-cartilaginous character. Lastly, fibrinous deposit progressing concentrically, may at length convert the bursa into a solid tumour, having a laminated structure, or leaving a small central cavity, containing a gelatinous fluid.

The *diagnostic characters* of these varied structural conditions is tolerably obvious. Inflammation, followed by suppuration and abscess, sloughing and ulceration, will be severally attended with their usual signs and symptoms.

Enlarged bursæ are chronic indolent tumours; with distinct fluctuation, denoting fluid contents, or having a solid resisting character according to the deposition of fibrinous matter. Thickening of the sac forms a semi-solid tumour, and the production of melon-seed-like bodies yields a crackling sensation on handling the sac, while complete solidification presents a hard elastic tumour.

Causes.—Some local injury, as pressure, friction, or a blow, is generally the cause, whether of inflammation or simple enlargement of a bursa. Occasionally, some constitutional tendency seems to have a predisposing, or possibly productive influence.

Treatment.—*Inflammation* may be subdued by rest, cold or warm fomentations, and topical bleeding. Suppuration having taken place, a free opening must be made and poulticing continued until granulation is established. *Chronic enlargement* of a bursa yields to various methods of treatment, according to the nature of its contents. An accumulation of serous fluid in the sac may be absorbed by a stimulating application, such as iodine paint, which I prefer. By puncturing the sac and pressure, or by the injection of iodine, adhesion can sometimes be induced; or the introduction of a seton for a few days leads to suppuration and contraction.

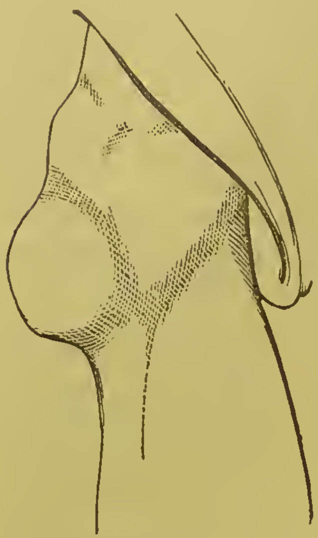
Fibrinous matter having been deposited, thickening of the sac, and an accumulation of melon-seed bodies within its interior, may possibly be cured by a seton, inducing discharge and contraction. But this condition, or that of complete solidification, generally necessitates removal of the bursa surgically. When fairly dissected out, the disease can never return, and commonly no evil consequences follow this operation. In one case only, after I had thus extirpated an old enlarged bursa patellæ, phagedænic gangrene appeared in the wound, and spread to some distance above and below the knee. But this was, evidently, an accidental coincidence, and no valid objection to the method of treatment.

PARTICULAR BURSÆ.—*Bursa Patellæ.*—The bursa situated over the patellæ is liable to the same diseases as those common to all bursæ. *Inflammation* and its consequences, or simple chronic enlargement, not unfrequently occur. "Housemaid's knee," as it is called, is an inflammatory affection of the bursa patellæ (Fig. 106), arising from frequent pressure and irritation by kneeling on a hard surface. But the same condition may be produced in other females and in males,

under similar circumstances. I have known it proceed to suppuration, as an acute abscess.

Caries of the patella—consequent on abscess of the bursa—and possibly involving the knee-joint, seems to be the only pathological peculiarity worthy of notice in connection with this disease.

Fig. 106.



The *treatment* is the same as that of bursal affections in general—the treatment of inflammation and suppuration; or, in a chronic state, stimulating applications, puncture and pressure, injection, a seton, or extirpation by careful dissection, having regard to the proximity of the joint to the enlarged bursa.

Bunion.—Inflammatory enlargement of the bursa situated on the inner aspect of the metatarsal bone of the great toe, or of an adventitious bursa formed in that situation, is the essential element of a bunion. The sac contains an increased quantity of thin serous fluid, or perhaps a dense crystalline secretion, as observed by Sir B. Brodie and M. Boyer. Over this enlarged bursa, a corresponding portion of thickened and horny cuticle, a large corn forms; both of which constitute the bunion. (Fig. 107.) The toe is generally displaced obliquely outwards, lying over or under the adjoining toes; thus forming an angle more or less obtuse at the metatarso-phalangeal articulation, or root of the great toe, and considerably increasing the prominence inwards. Acute pain, redness, and heat—the symptoms of inflammation—accompany this swelling, it being partly an inflammatory enlargement of the bursa.

Fig. 107.

Chronic bunion represents the result of this state, inflammation having subsided into a tolerably painless enlargement of the bursa; but which is liable to become acute under irritation.

The *cause* of this condition is the pressure of a tight and narrow pointed boot or shoe, habitually worn; whereby the toe gradually becomes turned outwards from its natural direction, increasing the pressure on the root of the toe projecting inwards. The formation of bunion is, therefore, mostly secondary to, and the consequence of, this displacement of the toe. Continued and increasing pressure thus bearing on the root of the toe, the bursa there situated enlarges, or a new one is produced, and the superimposed cuticle becomes a corn.

The *course* of bunion is apt to be very destructive. The internal lateral ligament yields under the constant strain, and suppuration within the bursal sac frequently supervenes, the abscess slowly progressing to the surface and opening by a small circular aperture in the centre of the horny callosity; or, destroying the ligament and involving the joint, the cartilages are eroded, the bones become carious, and partial dislocation inwards is permanently established.

Some relief of the intolerable pain and of the other inflammatory symptoms, follows any evacuation of matter; but an indolent and unhealthy sore remains, indisposed to heal.

Treatment.—Removal of the cause in operation is primarily important. A large shoe should be worn, or one with a compartment for the great toe, so as to keep the toe in a line with the metatarsal bone, and thus relieve pressure. By a contrivance of Mr. Bigg's, the toe can be drawn inwards. A compress of thick soft leather, spread with soap-plaster, and cut in the form of a horse-shoe, or a circular piece with a hole in the middle, may be applied; the opening corresponding to the bunion, which is thus relieved from pressure. Inflammation is to be overcome by the usual topical applications; poulticing or cold lotions, according to the state of the bunion. Abscess forming in the bursa, an opening should be made without delay, both to relieve the intense pain and prevent any destruction of the joint.

Chronic bunion is best removed by painting it with a strong solution of nitrate of silver. A large, and perhaps painful cyst, may be destroyed, as recommended by Sir B. Brodie and M. Boyer, by an incision into the sac, and cauterizing its inner surface with nitrate of silver or nitric acid. It should be observed whether the sac communicates with the joint. Destruction of the internal lateral ligament, and the articulation, may terminate well, by fixing the toe with a gutta-percha splint; or this condition will necessitate excision of the joint or amputation of the toe. I have resorted to the former operation successfully, in some cases.

Sheaths of Tendons.—(1.) *Tenosynovitis—acute and chronic.*—Sheaths of tendons in the neighbourhood of joints, are most liable to inflammation. This is attended with the effusion of fibrinous serum. The flexor and extensor tendons of the wrist, for example, are subject to strains in various laborious occupations. To guard against any such injury, it is not uncommon for navigators, and others similarly employed, to wear a band around the wrist, as a support to the tendons. Direct violence may also give rise to this inflammation; as in the foot, from contusion of the instep, or the chafing of a tight shoe. Sometimes the inflammation seems to be spontaneous or idiopathic.

Puffy swelling and some pain in the course of tendons, after injury, denote inflammation of their sheaths. A peculiar creaking, jerking sensation and sound is elicited on moving the part. This latter sign differs from the true crepitus of fracture. Febrile disturbance, more or less acute, accompanies these symptoms.

Tenosynovitis *terminates* perhaps by *resolution*, with slow absorption of the effusion; but, more often, *adhesions* take place between the tendon and its sheath, resulting in stiffness for some time; or a glairy, gelatinous fluid remains within the sheath, presenting a persistent, painless swelling—*chronic* tenosynovitis. Not uncommonly, the disease proceeds to suppuration, with sloughing of the tendons, which can be pulled out in the form of yellow shreds. The neighbouring joints may become anchylosed, or the bones necrosed. The spontaneous form of the disease—although rare—commences as a diffuse inflammation, involving the subcutaneous cellular texture, with great swelling, and rapid suppuration. In suppurative tenosynovitis, the hectic exhaustion and wasting are remarkable.

The *treatment* is in no way peculiar. Rest, and warm fomentations; followed by stimulant applications and pressure in the chronic state of inflammation. Blistering, embrocations, and a bandage are thus efficacious; or the emplastrum ammoniacum cum hydrargyro employed as

strapping, is both stimulating and supporting to the part affected. In the event of suppuration, incisions in the course of the tendons, and poulticing, will be necessary; when the sheaths may heal, with out-cropping granulations, leaving a stiffened hand or foot. But necrosis may yet compel the Surgeon to extract the dead bone, or to amputate the part.

(2.) *Ganglion.*—This is a simple or barren cyst or sac, attached to, but communicating with, the sheath of a tendon. It contains a firm, transparent, whitish gelatinous matter, resembling the vitreous humour of the eye. The cyst varies in size and shape, from a pea to a filbert; and presents a corresponding tumour, smooth, elastic, movable, and subcutaneous; situated usually on the back of the wrist, occasionally on the dorsum of the foot, as in a case which came under my notice. This little tumour is itself painless, even when pressed firmly under the thumb, although the patient experiences a sense of weakness in the joint.

Chronic ganglion does not so much increase in size, as the cyst attains considerable thickness and resistance. Arising from a sprain, or as it were spontaneously—unlike a subcutaneous bursa which proceeds from pressure—ganglion is usually of slow growth, but, sometimes makes its appearance quite suddenly.

Compound Ganglion is described by Erichsen, as a dilatation of the sheaths of the tendons; often attaining a very considerable size, and usually becoming irregular in shape, several tendons being implicated in it. The sheath becomes thickened as well as dilated, and highly vascular, being lined with a red, fringed, and velvety membrane; the contained fluid is clear and yellowish, but usually thinner than in simple ganglion; or the fluid may be dark and bloody, containing masses of buff-coloured fibrin or a large number of granular bodies, like those met in enlarged bursæ. "These bodies are composed of perfectly developed granulations, in which the remains of blood-vessels are visible, probably thrown off from the inner wall of the vascular sheath." Compound ganglion is chiefly met with in the palm of the hand, and on the dorsum, sole, or inner side of the foot. This form of the disease is extremely *chronic*, may acquire an almost malignant appearance, and occupy a very extensive surface; in one case, the dorsum and greater part of the inner side of the foot were involved. Simple ganglion, however, in this situation is larger, flatter, and less movable than on the back of the wrist.

Treatment.—*Simple* ganglion is usually amenable to remedial measures. In its ordinary situation, on the back of the wrist, a ganglion may be dispersed by squeezing it with the thumbs, or by a blow with the back of a book; the sac bursting and evacuating its contents under the skin. A *chronic* ganglion, having a thickened sac, may require considerable pressure before it yields, and the sac remaining may still give the appearance of a ganglion; deceiving both the operator and the patient, unless the sensation of bursting be noticed during the application of pressure. Often the cyst refills, and it will be necessary to continue pressure by means of a compress and roller, firmly applied. Occasionally also, other measures, as for an enlarged bursa, become requisite; puncture and pressure, a seton, or extirpation by dissection.

Compound ganglion—distension of the sheaths of tendons—is a far more obstinate disease; especially when forming in its usual situation,

the palm of the hand. The sheaths of the flexor tendons are distended, containing a glairy or other fluid. The elastic tumour, thus produced beneath the palmar fascia, extends under the transverse ligament into the forearm, in the form of a double swelling, constricted by the ligament. The fingers are contracted. Various plans of treatment may be followed. In the case of a surgeon, aged sixty-five, I made a subcutaneous small opening above the wrist, and evacuated a large number of melon-seed bodies, with a very successful result. Free incision of the tumour, dividing the annular ligament, and healing from within, as recommended by Syme, may be advisable, although apparently an extreme measure. But other proceedings—the passage of a seton from above under the annular ligament into the palm, or the injection of iodine—are more hazardous, by inducing inflammation which cannot be controlled so as only to obliterate the swelling.

NERVES.

CHAPTER XXIV.

INJURIES.—NEURITIS.—NEURALGIA.

Injuries.—Nerves are seldom injured alone, but in connection with other textures, the injury being shared in common with them. Nerves are, however, liable to similar lesions as other soft textures; wounds, incised, punctured, and contused, and to contusion without breach of continuity. Perhaps the latter lesion is the most frequent, as when the ulnar nerve at the elbow is contused by an accidental collision, just catching the nerve in its course between the inner condyle and olecranon.

The symptoms attending these forms of injury vary with the amount of injury to the nerve, and its own functional importance. Pain, tingling, or other perverted sensation, accompany contusion; complete paralysis of sensation, and of motion, in the parts supplied by the nerve, denote division. This has happened in excision of the elbow-joint; division of the ulnar occasioning immediate loss of sensation on both sides of the little finger and inside of the ring finger, with inability also to move these fingers. Sometimes loss of temperature and failure of nutrition supervene; owing probably to the loss of nervous influence on the circulation in the part to which the nerve is distributed, and the finger, as I have seen, may become atrophied.

Fortunately, restoration after contusion, and reunion after division, not unfrequently take place; the nerve sooner or later resuming its functions. In large nerve-trunks, as the sciatic and median, the original structure is not completely reproduced. When, also, a portion of nerve has been excised, to the extent of, say, the third of an inch, the divided ends remaining apart, such portion will not be reproduced. The cut end of a nerve—as in an amputation-stump—often enlarges into a club-shaped or bulbous extremity, consisting—Billroth observes—of convoluted nerve-filaments; which grow from the nerve-end, as if to meet an opposite end. The cicatrix of a divided nerve is sometimes nodular, in like manner.

The *treatment* will, therefore, be guided by these indications of nerve-reparative power. Rest in all cases, and apposition of the ends, if the nerve be divided.

NEURITIS.—*Symptoms.*—Inflammation of a nerve is attended with pain, severe and continued, shooting along the nerve or nerves affected; and rendered intolerable by pressure in their course, or on attempting to move the part. Jerking of the muscles often occurs. Some heat and swelling along the course of the nerve may perhaps be detected, if the inflamed nerve be situated near the surface. Marked inflammatory fever is present in all cases. *Chronic* neuritis is distinguished by a subsidence of all the symptoms, leaving the nerve still sensitive, and sometimes painful; and the individual worn out by suffering and sleeplessness.

Causes.—Usually arising from injury, the various lesions to which nerves are liable may induce inflammation, extending along the sheath of the injured nerve. But neuritis may also proceed from some blood-poison, of which it is the local, or one of the local, manifestations. Sciatica is probably a manifestation of this kind; a rheumatic inflammation of the sciatic nerve.

Treatment.—Local blood-letting and warm fomentations are most suitable in neuritis of traumatic origin; while opiates or sedatives, as hyoscyamus or conium, may procure sleep, or relieve the otherwise incessant suffering. Rheumatic neutritis must be treated, locally and constitutionally, as acute or chronic rheumatism.

NEURALGIA.—*Symptoms, and Diagnosis.*—Pain is still the essential symptom of neuralgia, as in neuritis. It may be even more severe or excruciating, but it is paroxysmal; shooting along the course of a nerve, or diffused, but commonly relieved by firm pressure, although generally induced by the slightest superficial touch or movement of the part. Various anomalous sensations may be experienced, as creeping, tickling, or burning in the part. Spasm of the muscles is a frequent concomitant. Slight heat, puffiness, and redness may supervene, and increased secretion, as of tears or saliva when the nerves of the eye or jaw are affected. But no fever of an inflammatory character accompanies the attack. Its duration is usually much shorter than neuritis; lasting perhaps only a few minutes, although prolonged indefinitely in some cases. The periodical return of neuralgia, at a certain time in the day, or in certain months of the year, is also characteristically distinctive.

From *structural* disease of the part, neuralgia is distinguished by the absence of any special physical signs—*e.g.*, inflammatory swelling, and of fever; and also by the character and disproportionate severity of the pain. From hysterical pain, it differs in mostly being restricted to one part, and by the absence of general hysterical symptoms.

The association of structural disease with neuralgia is sometimes most perplexing. But here—and with regard to hysteric pain—the diagnosis may be determined by the aggravation of the pain by deep pressure, rather than any marked cutaneous sensibility. The mistaking structural disease for neuralgia would mislead the treatment; but this error is not so seriously misleading as the mistaking neuralgic pain for structural disease. By attention to the foregoing points of distinction, the line may generally be safely drawn between neuralgia and disease of the joints, the breast, testicle, and other parts.

Certain nerves are more frequently the seat of neuralgic pain. The

divisions of the fifth pair are specially liable; and in particular the supra-orbital branch. But neuralgia may occur in perhaps any part of the body; in the scalp, ear, nose, back of the neck, the back, chest, breasts, testicles, clitoris, abdomen, arms, ball of the thumb, legs, feet; or in the joints, especially the knee and hip. The ends of nerves in amputation-stumps are not unfrequently affected; but more often when they present bulbous enlargement, and are adherent to the cicatrix.

Causes.—Constitutional conditions, mostly of an obscure character, seem to be the essential cause of all this suffering. A generally depressed state of the nervous system, and circulation of the blood, may be said to represent the constitutionally causative condition, usually apparent. Thus, constant exposure to wet and cold, the climatic influence of damp localities, or periods of the year, depressing passions, not unfrequently induce neuralgic attacks in persons previously healthy. Certain blood-poisons are less obvious, but not less potent. The malarious poison of marshy districts is thus sometimes the source of the most severe and persistent neuralgia. Chlorosis from amenorrhœa is another such cause. The influence of blood-conditions may be even more frequent in albuminuria; a disease in the course of which I have witnessed neuralgic attacks of more intense agony, than in any other disease. It was a sagacious remark by Romberg, I believe, that neuralgia is "the prayer of a nerve for healthy blood." *Local* irritation is often the immediate and exciting cause. A carious tooth, or piece of dead bone elsewhere, the accumulation of scybalous matter in the intestinal canal, or other sources of irritation, centric or eccentric, are causes of this kind. The pressure of a tumour in the course of a nerve, or a neuromatous tumour itself, would sometimes appear to be causes of neuralgia; but any injury to, or disease of, the nervous system is in this sense causative. Dr. Pemberton suffered for many years from excruciating pains in his face, to relieve which Sir A. Cooper severed the three divisions of the fifth nerve, on different occasions, without avail. Driven from practice, and worn out by protracted suffering, at length death brought that release which art had failed to give. A tumour was then found in the brain; and thence the origin and persistency of the pain endured during life.

Course and Terminations.—Neuralgia is as uncertain in its subsequent history, as its pathology and etiology are obscure. The attacks may cease suddenly, leaving the individual in apparently good health, or soon to recover from the temporary exhaustion consequent on pain and sleeplessness. Or the sufferer at length succumbs, dying from sheer exhaustion.

Treatment.—For the treatment of neuralgia, only certain general directions can here be given. The *cause* or causes in operation must be diligently sought for, in each case. It will be useless, however tempting, to remove a merely local cause, when the constitutional condition is still in operation. A change of residence from a damp or malarious locality may thus be necessary. Other depressing circumstances, already noticed, are less under control. *Medicinal* treatment may, however, do something, preventive or curative. Quinine, in large doses—two, three, five grains, or more—will sometimes ward off an attack, or cut it short. Quinine treatment, continued in smaller doses, sometimes proves curative. Preparations of iron, the sulphate in particular, are more effectual in neuralgia of malarious origin. In albuminuria

the blood-restorative action of iron is counteracted by the constant retention of urea and other excrementitious matters in the blood. Disordered menstruation may perhaps be remedied by the administration of emenagogues—*e.g.*, galbanum, myrrh, etc.—in conjunction with tonic treatment. Constipation or irregular action of the bowels must be overcome by aperients, chosen according to the occasion. Thus, aloetic purgatives, rhubarb, mercurials, and salines, are all useful, in different cases.

Any *local* cause of irritation should not be overlooked, but its removal will seldom overcome a true neuralgic tendency. The extraction of a carious tooth, for example, seems only to divert the recurrence of pain to another, and possibly sounder tooth. Local applications, sedative or counter-irritant, are comparatively useless. Belladonna, opium, aconitina, and other powerful sedatives have been tried in vain. The hypodermic injection of morphia is perhaps more promising. Blistering, or stimulant embrocations, will rarely be tolerated by the patient.

Section of the nerve is a last resource. It cannot succeed in cases of neuralgic pain depending on pressure in the course of a nerve, unless the occasion of pressure can be detected, and the operation be performed above that part. It was thus unavailing in the case of Dr. Pemberton. When appropriate, the section must be an *excision* of a portion of the nerve, the simply divided ends otherwise regaining their continuity.

NEUROMATOUS TUMOUR.—See MORBID GROWTHS.

ARTERIES.

CHAPTER XXV.

INJURIES OF ARTERIES.—ANEURISM.

WOUNDS—and of SPECIAL ARTERIES.—These Injuries are conveniently associated, respectively, with WOUNDS in general (Ch. XVI.) and with TRAUMATIC ANEURISMS in various parts of the body. (Ch. XXVI.)

FIG. 108.*

ANEURISM.—*Structural Conditions.*—Aneurism may be generally defined to be a collection of arterial blood communicating with an artery, from which it has arisen. (Fig. 108.)

This collection of blood may be *circumscribed*, commonly, by enclosure within a dilated portion of the artery, as a sac, forming *true* aneurism; or possibly within a sacculated dilatation of its external cellular coat alone, the internal

* True saccular aneurism, in arch of aorta; with laminated clot-formation. (After Hodgson, slightly modified.)

and middle coats having become ruptured—*mixed* aneurism; or, the blood may become enclosed within condensed cellular texture of the part, external to but adjoining that of the artery, thus forming a sac enclosing blood, and constituting circumscribed *false* aneurism; or, the blood having escaped from the artery into the adjoining cellular texture, may remain diffused therein, constituting *diffused* false aneurism. Whether this condition shall remain, or form a *circumscribed* false aneurism, will depend chiefly on the degree of looseness

Fig. 109.*

Fig. 110.†

or density of the surrounding cellular texture, on the size of the artery, and the direction of the opening in it; and, moreover, is regulated by the force and rapidity of the current of blood passing through the vessel. The accompanying figure represents a diffused aneurism becoming circumscribed. (Fig. 109.)

Other forms of Aneurism are recognized by Surgical Authors. *Fusiform* or *Tubular* Aneurism is a dilatation of all the coats of an artery, extending throughout the entire circumference of the vessel,

* Double-sacced aneurism. The first sac had burst, and the tumour became diffused; but a second sac of surrounding textures again formed a circumscribed aneurism. (From Sir Charles Bell.)

† Dissecting aneurism of aorta,—between the external and middle coats, and extending from the left subclavian artery down to the bifurcation of the abdominal aorta. The tube of the aorta was quite pervious, although compressed by a large firm clot, at the bifurcation; but the left common iliac was obliterated to a fibrous cord. (Path. Trans. vol. vii., case by Dr. Latham, *pro* Dr. Swaine.)

and not forming a sac. It commonly occurs in the arch of the aorta. *Dissecting* aneurism is sacculated, but the sac is formed between the coats of the artery, and generally between the internal and middle coats, which have become separated or dissected up by the force of the blood, the inner coat having given way. Or, the sac may form between the *external* and middle coats of the vessel. (Fig. 110.) The sac thus situated may extend a considerable distance along the vessel. Dissecting aneurism was first described by Shekelton.

SIGNS.—The physical signs of aneurism vary with its condition. *True* aneurism at first presents a small, soft, circumscribed tumour (Fig. 112), pulsating with an expansive movement to the touch, to the eye, and to the ear,—as a rasping or sawing sound or bruit,—in unison with each beat of the heart. These characters may be rendered more perceptible by arresting the current of blood with the finger on the artery, below the aneurism. The pulsation ceases and the tumour itself subsides, if the current of blood through the aneurismal sac be arrested by compressing the artery above the aneurism; but on allowing the blood again to flow, the tumour refills, with a sudden and expansive impulse. And, at this early period, the sac can be emptied by pressure, and the blood thus returned into the artery.

Mixed and *circumscribed false* aneurism, respectively, are not characterized by any peculiar signs; either of these forms of aneurism presenting a circumscribed tumour, and in its early stage beating and thrilling under the finger, yet being also reducible.

Seeing then that the signs of these three forms of aneurism are indistinguishable, their distinctive names are, in my opinion, *practically* useless. In the course of time, the aneurismal sac, enlarging and borrowing more and more fibrine from the passing stream of blood, becomes partially consolidated. The tumour, as felt externally, is, therefore, no longer soft, although still circumscribed; its pulsations are fainter and less expansive, and the swelling cannot be reduced by compressing the vessel above, nor by direct pressure without such force as would break up the clot. The sound or *bruit* also, produced by the pulse-wave of blood through the aneurism, may now be absent; as when the neck of the sac is too narrow to readily admit the current of blood into the sac, or if the sac be consolidated with coagulum. Hence, the characteristic signs of aneurism are modified or absent.

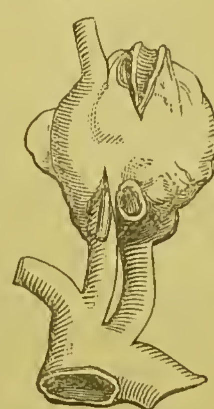
Diffused false aneurism, in virtue of its essentially distinctive condition from that of any circumscribed aneurism, might be designated simply,—Diffused Aneurism. The tumour is generally of much larger size than a circumscribed aneurism; its outline is no longer defined, the pulsations are fainter and more indistinct or quite imperceptible; and the blood, being infiltrated, cannot be returned into the aneurismal artery. The swelling resembles a large ecchymosis, the superjacent integuments being discoloured like an extensive bruise. The limb or part dependent on the artery for a due supply of arterial blood, becomes cold and œdematous, threatening gangrene. If the diffused form be *consequent* on circumscribed aneurism, the individual will have felt something give way suddenly, followed immediately by notable enlargement of the aneurismal swelling, accompanied with intense pain and faintness. The former symptom—sudden accession of intense pain, is due to tension from the diffusion of blood among the textures and possibly under unyielding fasciæ; the latter symptom — faintness,

arises partly from shock, by the pain of tension, and partly from the loss of blood in circulation, by its extravasation.

The *functional* symptoms of aneurism are pain, loss of muscular power, and venous congestion; or there may be special functional disturbances in connection with internal aneurisms. These do not occur until a rather late period of aneurism, and do not accompany it throughout its career.

DIAGNOSIS.—The *physical* signs of aneurism, already described, may themselves be absent; as when consolidation in the sac has taken place. Or, if these signs be *present*, they may arise from other causes, other *pulsating* tumours. Such are vascular or erectile tumours, and certain tumours of a highly vascular character, as encephaloid cancer. The diagnosis will be determined by comparing the signs of these tumours with those of aneurism. Then, again, a tumour or an abscess seated on an artery pulsates, and thus simulates aneurism. (Fig. 111.) In the instructive specimen here represented, a firm tumour encloses the left common carotid artery; and in which the internal jugular vein and pneumogastric nerve are embedded and compressed. Thrombosis had taken place within the vein, thus further obliterating this vessel. But the pulsation of any superimposed mass is not expansive and uniform over its whole surface; the tumour does not subside if pressure be made on the artery above, although the pulsation ceases; and it cannot be emptied by direct pressure. It should, however, be remembered that these negative signs are equally true of aneurism which has undergone consolidation. In some doubtful cases, the tumour can be lifted off the artery; thus plainly declaring its independence. There are also frequently present the characteristic signs of the particular kind of tumour or swelling. But an abscess may have communicated with an artery, by an ulcerative opening in the walls of the vessel; thus converting the abscess into an aneurismal sac, as in the well-known case of pseudo-carotid aneurism which Liston opened for an abscess, by an error of diagnosis. From the pain of rheumatism, aneurismal pain may be distinguished by its intermittent character, and the presence of physical signs; coupled, generally, with the number of parts affected in the case of rheumatism. Neuralgic pain has also its differential, although less distinctive, characters.

FIG. 111.*



Diffused aneurism is far less likely to be equivocal, its signs being more peculiar.

The *history* of aneurism will further aid in determining its diagnosis. If the tumour be circumscribed, by conversion from diffused aneurism, there will be the antecedent transition changes from *that* condition. If diffused, by conversion from circumscribed aneurism, there will be antecedent transition changes from *that* condition; if originally diffused, there will be the antecedent fact of traumatic origin.

CAUSES, EFFECTS, AND COURSE OF ANEURISM.—Aneurism commonly arises from an *internal* cause; namely, a diseased or atheromatous condition of the artery, by fatty degeneration into oil-particles, with crystals of cholesterine, and subsequently calcareous degeneration; affecting the

* Royal Coll. Surg. Mus., 1741. (Hunterian.)

middle or muscular coat of the vessel. In the fatty or atheromatous stage of degeneration, the inner aspect of the artery presents slightly elevated patches, yellowish and opaque, underneath the thin inner membranous coat; in the calcareous stage, it becomes inelastic and brittle, and the patches assume the character of bony plates, consisting of mineral salts, the phosphate and carbonate of lime, but having little or no osseous structure; lastly, the inner coat or lining membrane gives way, or disappears. The degenerated portion of artery having lost its elasticity, and perhaps being partially ruptured, is disposed to yield to the pulsating action of the arterial wave-current, and expand into an aneurismal sac. Hence, the formation of *idiopathic* Aneurism, which is primarily circumscribed, and secondarily only becomes diffused, by rupture; or eventually perhaps again circumscribed, by fibrinous consolidation. Billroth notices inflammatory softening of an artery as a rare cause of aneurismal enlargement; thus far regarding aneurism as an occasional consequence of arteritis, and when of an acute and idiopathic character.

The *number* of aneurisms which are liable to form, simultaneously or successively, in the same individual, is mainly determined by the nature of the internal cause in operation. Fatty and calcareous degeneration not unfrequently affects a large extent of an artery, as the aorta, or many arteries, as both popliteals and other vessels. Thence the production of more than one, and even numerous aneurisms, in the same person. Sixty-three, for example, were found in one individual, whose body was examined by Pelletan.

Predisposing Causes vary in their nature and degree of influence. *Age* is important, but apparently only as connected with those degenerative changes which the arteries, in common with many other textures, undergo as age approaches. Thus, according to the observations of Sir A. Cooper and Lisfranc, aneurism is most frequent about the middle period of life, or between the ages of thirty and fifty; whereas ten years on either side of these ages makes a very favourable difference —under twenty, and after sixty, the disease being exceedingly rare. Certain *blood-diseases* seem to have some predisposing influence. Syphilis, gout, and rheumatism have this reputation. *Climate* appears to possess an inexplicable predisposition; aneurism being far more common in cold than in hot countries. The immunity of the East Indies contrasts favourably with the climate of Great Britain and Ireland. *Occupation* has an unquestionably important influence, and especially in connection with previous habits of life. Thus, any violent exertion, and by persons who are habitually sedentary, is conductive to aneurism. Hunting, pedestrianism, rowing and other athletic sports, may therefore have this tendency. Such pursuits seem to favour the production of aneurism, by repeatedly exciting a powerful action of the heart and compression of the arteries, in muscular exertion. *Sex* is thus associated with predisposing causes; aneurism occurring more frequently in men than women, in about the proportion of 8 to 1, according to Hodgson's table; or nearly 11 to 1, in the cases of surgical aneurism, 154, collected by Lisfranc. The liability of different *arteries* to aneurism has been shown by Lisfranc to vary in the following order of frequency, as gathered from 179 cases, all spontaneous, but excluding those of the aorta:—Popliteal artery, 59; femoral, in the groin 26, at other points 18; carotid, 17; subclavian, 16; axillary, 14; external

iliac, 5; brachio-cephalic, 4; brachial, common iliac, anterior tibial, of each, 3; gluteal, internal iliac, temporal, of each, 2; internal carotid, ulnar, peroneal, radial, palmar arch, of each, 1.

The *external* causes of aneurism relate to injuries of various kinds affecting the arteries, as an external wound, a fracture or dislocation, opening an artery; or, a strain, blow, or bruise, inducing sloughing of the vessel. Hence the formation of *traumatic* Aneurism; which is primarily diffused, and secondarily only becomes circumscribed, in favourable cases.

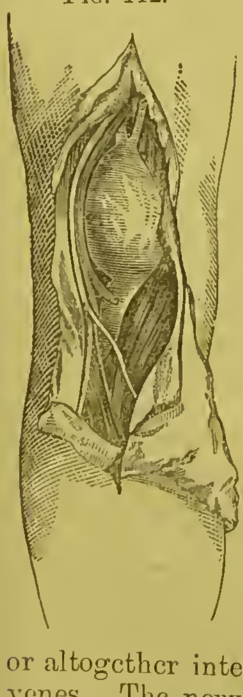
The relations of *origin* and *structural condition*, in respect to Aneurism, are clearly represented in the following Table :—

ANEURISM.

Origin.	Idiopathic	Circumscribed—primarily.
		Diffused—secondarily.
	Traumatic	Diffused—primarily.
		Circumscribed—secondarily.

The *mode* of origin in no way affects the signs and the diagnosis of Aneurism—there the structural conditions, circumscribed and diffused, are the grounds of distinction; but the etiology of Aneurism affords the most significant indications as to treatment. This will appear presently. While, therefore, I recognize the perceptible distinctions, circumscribed and diffused Aneurism; I would supplement this diagnosis, by associating therewith that condition of the artery, whether of disease or injury, which is suggested by the origin of the aneurism, as idiopathic or traumatic.

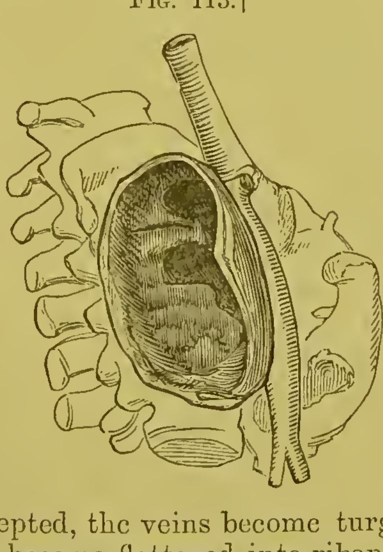
FIG. 112.*



The *effects* and the *course* of Aneurism have both local and constitutional relations.

Locally, *circumscribed* Aneurism produces pressure-effects. The sac of blood, fluid or semi-solid, pulsating and gradually enlarging, exerts a constant, expansive, and increasing circumferential pressure; producing various functional disturbances and alterations of structure in surrounding parts, as exhibited by the pressure-effects of popliteal aneurism. (Fig. 112.) The current of blood, through the artery, being more and more obstructed, or altogether intercepted, the veins become turgid, and œdema supervenes. The nerves become flattened into ribands, occasioning intense pain, or eventually, partial paralysis; the muscles waste, and the

FIG. 113.†



* From Sir A. Cooper.

† Aneurism of abdominal aorta, at bifurcation. Destruction of bodies of vertebræ, leaving inter-vertebral fibro-cartilages. Univ. Coll. Mus., 2741.

bones erode, without, however, the accompanying formation of pus, as in caries. (Fig. 113.) The bursting of circumscribed aneurism, and its conversion into the diffused condition, takes place in two ways. By *sloughing* and rupture of the skin, or of the mucous membrane in certain internal aneurisms; or by *fissure* of a serous membrane, if the aneurism burst into the peritoneum, the pleura, or pericardium. The hæmorrhage, taking place externally or internally, is sometimes suddenly fatal, or it recurs again and again, and thus at length proves fatal. Various special functional disturbances may be produced, according to the particular seat of aneurism. Thus, aneurisms of the aortic arch give rise to aphonia and cough, by pressure on the left recurrent laryngeal nerve; or to dyspnœa and dysphagia, when the trachea and œsophagus are compressed. With *diffused* Aneurism, the functional disturbances—consequent on the circumscribed condition—may persist, or be relieved, temporarily or permanently. Yet with progressive enlargement of the diffused tumour, other functional disturbance and alterations of surrounding parts supervene. *Constitutionally*, the influence of Aneurism varies with its structural condition. If circumscribed, the tumour may induce some degree of inflammatory or sympathetic fever, arising from the local irritation; but this is succeeded by exhaustion, from prolonged pain and sleeplessness. If the aneurism be diffused, the same constitutional disturbances ensue; and, when circumscribed aneurism becomes diffused, this alteration of structural condition is accompanied, as already stated, by more or less shock, which is due both to the sudden and severe pain, and to the equally sudden hæmorrhage or loss of blood in circulation.

TERMINATIONS.—Aneurism may undergo reparation, or spontaneous cure, as it is termed; or burst, and eventually prove fatal by hæmorrhage, externally, internally, or in both directions. Death may, however, result from functional disturbance, induced by pressure, involving some important organ; as in aortic, and other internal aneurisms.

(1.) *Spontaneous Cure.*—*Circumscribed* Aneurism is naturally disposed to undergo spontaneous cure. The *essential* nature of this process is coagulation of the blood within the aneurismal sac; for although coagulation therein may occur naturally under four or five different contingent circumstances, as *modes* of cure, they alike tend to thus obliterate the aneurism. The *principle* of cure will be readily understood. Aneurism arises whenever the force and velocity, or the *impetus* of the blood's motion through any given artery, or is no longer counterbalanced by the elasticity and contractile force, or the resisting strength of the walls of that vessel. Coagulation of the blood within the aneurismal sac tends to restore this resisting strength, and is therefore proportionately conducive to the cure of aneurism. The *details* of this process are briefly these:—The blood continuing to flow through the aneurism, leaves upon the interior of the sac a thin layer of coagulum, upon which another is superimposed, and so on, forming a laminated coagulum; the outermost portion of which, attached to the sac, acquires considerable firmness and resisting strength. This consists of distinctly laminated fibrine. (See Fig. 108.) It eventually becomes somewhat friable, and resembles boiled beef in colour. The portion of coagulum next in order has the consistence and appearance of damson cheese; while the innermost portion, in contact with the flowing blood, is semi-fluid, like currant jelly. By this successive

deposition of coagulum the sac is gradually filled up to the level of the artery, which still remaining pervious, the surface of coagulum exposed to the current of blood acquires a smooth and membranous appearance. In a large artery, through which the blood flows with most force, coagulation within the *sac alone* may be the whole extent of spontaneous cure. Its external *signs* are :—gradual solidification of the aneurism; less and less forcible expansion; the pulsation becomes that of a solid tumour; and, lastly, the swelling cannot be reduced by pressure applied to the artery above, or by compressing the aneurism. In aneurism of an artery of the second or third magnitude, through which the current of blood flows less forcibly, coagulation advances from the sac into the *vessel*, which gradually becomes plugged up, above and below, with a coagulum, extending to the next important branch above and below the aneurism. This advance of coagulation is accompanied with the cessation of pulsation. Eventually the aneurism contracts and dwindles into a comparatively small solid swelling; while the artery, to some extent, above and below it, is converted into an impervious fibrous cord. During this process of obliteration, compensation has been gradually made for the loss of the original supply of blood through the artery. The collateral branches above the unobliterated portion of artery enlarge with the additional flow of blood through them, and becoming equal to their extra duty, at length convey as much, or even more, blood than the aneurismal artery formerly supplied. The circulation is adequately restored, and nutrition efficiently sustained, by this compensatory supply of blood.

Remembering the internal cause of idiopathic aneurism, the inelastic or partially ruptured condition of a degenerated portion of artery, as already explained, and also the physiological fact that the coagulation of blood is favoured by *rest*, we at once perceive how anything which *retards* the flow of blood through an aneurismal sac tends to restore its resisting strength, and is therefore proportionately conducive to the cure of aneurism. The same effect is produced by anything which *otherwise* favours coagulation of the blood within the sac.

Firstly. The flow of blood may be retarded by a less forcible propulsive power of the heart; in which case coagulation is possibly induced without any co-operative condition incidental to the aneurism itself. The sac is gradually filled up to its brim; then, possibly, the artery is plugged, and finally obliterated. This is the usual mode of spontaneous cure.

Secondly. The flow of blood through an aneurismal sac may be retarded by a piece of clot dislodged from the sac, and washed into the mouth of the distal portion of artery, or impacted within it some distance off; embolism thus taking place. This condition may be followed by gangrene, from sudden occlusion of the artery, without the simultaneous provision of a collateral circulation. Thus for aneurism by a natural mode of cure, another evil would be substituted.

Thirdly. A piece of clot may be floated down to the aneurism from one higher up, or the retarded flow of blood above may induce coagulation in the lower sac.

Fourthly. The flow of blood may be retarded by the aneurism overlapping and compressing the portion of artery immediately above or below itself.

Fifthly, Coagulation of the blood within an aneurismal sac may be induced otherwise than by any occasion of a retarded flow of blood. Adhesive inflammation possibly, and certainly sloughing, obliterates the sac, and leaves the artery impervious.

Several remarkable instances of spontaneous cure by closure of the sac *alone* are recorded in Mr. Hodgson's work. Not only aneurisms of the aorta, but also those of smaller arteries, *e.g.*, the brachial and anterior cerebral, were thus effectually closed, without any obliteration of the aneurismal artery. For similar instances, where the aneurisms were due to unskilful blood-letting, the reader is referred to the works of Scarpa, Petit, Foubert, and Saviard.

In an aneurismal dilatation of the *whole circumference* of an artery —*Fusiform* or *Tubular* Aneurism—the cure by coagulation is just possible, only modified in a remarkable manner to meet the exigencies of the case. In one case, recorded by Sir A. Cooper, the femoral artery, from its origin to the extent of more than three inches, was dilated into a sac, which was lined throughout with very firm layers of coagulum, having a fleshy appearance. But this deposition did not completely obstruct the passage through the sac; for an irregular canal, in some places larger than the natural bore of the artery, still remained through its centre. The coagulum that formed the immediate boundary of this canal was more condensed than any other portion of the whole, and had a membranous appearance. Here, then, while coagulation had effectually *strengthened* this important artery, its *continuity* was preserved by an adequate channel through the coagulum. Only so much, and no more, coagulum had formed as was absolutely necessary to accomplish this twofold purpose.

Aneurism sometimes terminates safely in another way; but, not implying the favourable course and tendency of this disease, it must be regarded rather as an accidental mode of recovery, by an *evil* occurrence, than as a mode of natural cure, although no assistance is given by art. I allude to the bursting of an aneurism under a tight fascia, or other resisting structure, and compression of the sac and artery, even to obliteration, by the extravasated blood. One example of this kind is related by Sir A. Cooper. An aneurism of the femoral artery, just below Poupart's ligament, having burst, the thigh became enormously swollen. For three days afterwards, pulsation was perceptible over the aneurism. Then, however, it ceased, and the size of the limb began to diminish. At the end of four months, the aneurismal swelling had considerably subsided; the patient could use his limb, and in less than six months he quitted the hospital. Subsequently he died from the rupture of an abdominal aneurism, and *post-mortem* examination showed that the femoral artery was obliterated by the pressure of the large quantity of blood effused.

Another mode of accidental recovery through a circumstance itself *morbid*, is by the pressure of an aneurism of a neighbouring artery, or by that of a tumour not aneurismal. Liston mentions the instance of a subclavian aneurism, which on dissection was found solidified by the compression of another aneurism springing from the innominate artery.

(2.) *Diffused* Aneurism, when it remains in this condition, runs the course already indicated by its operation as an internal cause of local and constitutional disturbances. The tumour progressively enlarging even to an enormous size, and ultimately bursting, externally, inter-

nally, or in both directions, the career of such aneurism tends inevitably to further and fatal hæmorrhage.

Duration of Aneurism.—This would seem to be regulated chiefly by the force of the circulation, the proximity of the aneurism to the heart, the size of the neck of the sac, and its direction relatively to the current of blood, and by the coagulating power of. the blood. Rest, and the mode of treatment, will further affect the duration of aneurism. But the course of all aneurisms is generally slow; extending to a few months, a year, or possibly several years. In one extreme case of femoral aneurism recorded by Hodgson, the period of its duration was twenty years.

Prognosis.—The prognosis of Aneurism should be determined mainly by a due consideration of the persistency, or otherwise, of its causes. Degeneration of structure, affecting the coats of an artery, implies the loss of that adequate resistance and resiliency to the current of blood, which having given rise to Aneurism will also perpetuate it. The extent to which degeneration usually affects the arterial system, more than one artery being the seat of this destructive change, is an additionally unfavourable consideration. Hence, a *single idiopathic* aneurism always suggests a suspicious prognosis. *Traumatic* Aneurism suggests an unfavourable prognosis, only in proportion as the aneurismal swelling is progressive. The conditions which mainly regulate the *duration* of aneurism are obviously important, as persistent causes in regulating its dilatation and progress. In so far as these conditions are discoverable during life, their consideration will complete the prognosis. Special aneurisms are subject to particular conditions which determine the Surgeon's judgment respecting their course and issue, as in the case of internal aneurisms.

Treatment.—Remedial measures—hygienic, medicinal, and operative—should be entirely responsive to the natural or spontaneous cure of aneurism. The ordinary mode in which natural cure takes place is by retardation of the current of blood through the aneurismal artery, sufficiently to induce coagulation and the deposition of laminated fibrine within the sac.

i. As conducive to this end, the primary indication of treatment is *rest*, prolonged rest, of mind and body. *Position* is an important adjunct, by taking off the force of the arterial current. The recumbent position will be most suitable for aneurism in any part of the body, the patient not being allowed to raise himself once from the bed during a course of many weeks. *Gradual starvation* and *depletion*, to diminish the quantity of blood in circulation, and to reduce the force of the heart's action, have some remedial influence; but only within judicious limitations. The pulse should be maintained a little above 60, and at an equable rate. Farinaceous, rather than animal food, a sparing proportion of liquids to the smallest quantity which can be tolerated, and total abstinence, if possible, from stimulants; such are the chief features of the diet to be observed. That which was recommended by Bellingham answers to this description. It consisted of two ounces of bread-and-butter for breakfast, two ounces of bread and the same quantity of meat for dinner, and two ounces of bread for supper, with a little milk and water, occasionally, sipped in small quantities. Depletion by watery purgatives is preferable to blood-letting; and should the latter be resorted to, it is, in Sir Thomas Watson's judg-

ment, remedial only so far as it reduces any excessive force of the circulation. The small and repeated bleedings practised by Valsalva, may be beneficial in some cases; but certainly not when pushed to the extreme he recommended; syncope, when the patient attempted to stand, or even on rising in bed. Laxative aperients have also the advantage of preventing any straining effort in defecation. Respecting *medicinal* measures for controlling the heart's action, I have no authentic information to offer. The therapeutical results of medicines having reputed efficacy in relation to aneurism are vague and unsatisfactory. Narcotics may be administered to relieve pain and procure sleep, and thus maintain a tranquil state of the patient.

Having succeeded in lessening the *force* of the circulation, sufficiently to diminish the expansive pulsation of the aneurism, are there any known means of *directly* favouring the *coagulation* of blood, and the deposition of laminated fibrine, within the sac? By increasing the quantity of fibrine in the blood and its tendency to coagulate—in short, by improving the plasticity of the blood itself, this indication may be fulfilled. Animal food, therefore, should now be substituted for farinaceous, and in larger quantity; but the same restriction, or nearly so, should be observed with regard to liquids, and particularly stimulants. This combination of measures, for lessening the force of the general circulation, and then supplying the fibrinous material for coagulation, constitutes the *régime* originally proposed by Valsalva, and known also as the *internal* method of treatment. Pathologically correct in itself, it was wrong only in the extreme degree to which he carried it in practice; but recently, the same method has been rectified and ably advocated by Mr. Jolliffe Tufnell,* and is specially commended by Mr. Holmes.† I have practised it, in conjunction with the treatment of external aneurism by compression, in cases of popliteal aneurism.

Certain *local* applications externally are said to aid the coagulation of blood within the sac, but their efficacy is doubtful. Ice enjoys the repute of being thus beneficial; its constant or repeated application is, however, apt to endanger sloughing of the integuments. Its occasional use may relieve pain. But, for this purpose, the belladonna plaster, or an embrocation composed of equal parts of oil and of the strong tincture of aconite, form topical appliances which, according to Mr. Erichsen's experience, afford much relief.

ii. *Mechanical*, and *Operative, resources;* obediently to the *first* mode of natural cure.

In the event of an endeavour to reduce the force of the *general* circulation, and thus to favour coagulation in the sac, having proved unsuccessful; recourse must be had, without further delay, to such local measures as may retard the force of the arterial current through the *aneurismal artery*, exclusively. Mechanical appliances for this purpose favourably contrast with any cutting operation. The former mode of treatment anticipates the necessity for obliterating the aneurismal artery, and avoids also the danger consequent on any operative procedure for securing the vessel.

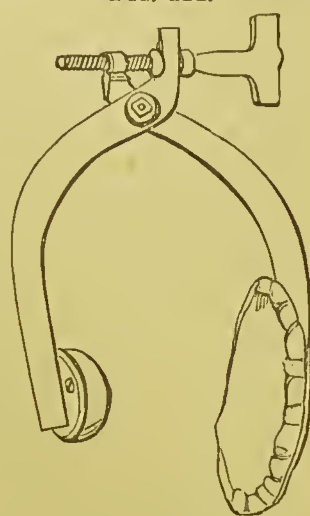
(1.) *Compression* of the artery *above* the aneurism. This plan of mechanical treatment should be guided by two principles. It is un-

* "The Successful Treatment of Internal Aneurism." 1864.

† "Lectures on the Surgical Treatment of Aneurism." Royal College of Surgeons. Pub. in *Lancet*, 1872.

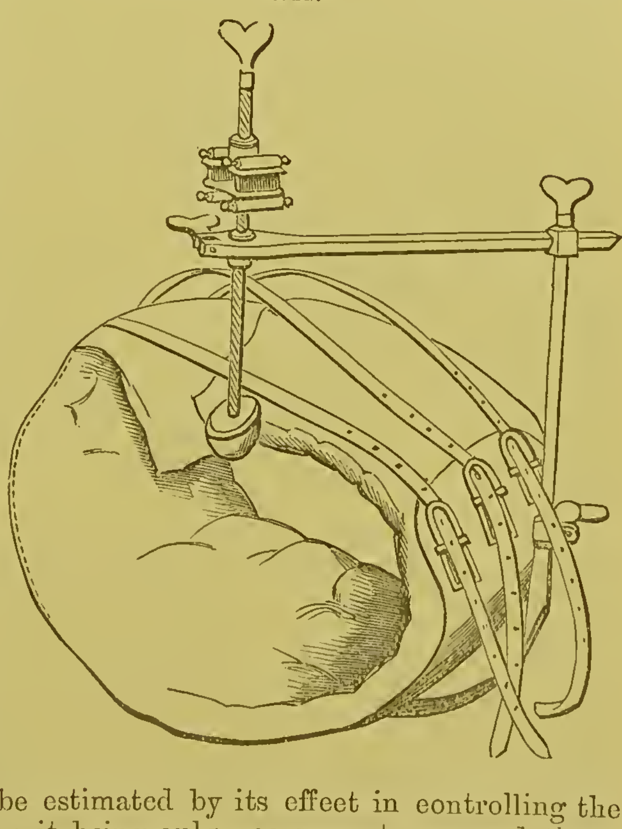
necessary to entirely arrest the stream of blood through the artery above the aneurism, and therefore unnecessary to obliterate the vessel by inflammation, in order to effect a cure. It is only requisite to lessen the *force* of the stream, and *temporarily ;* in order to give a fair start to the deposition of laminated fibrine, and so at length regain the balance of resistance naturally offered by the artery to the pulse-wave of blood passing through it. A degree of compression just sufficient for this purpose, and applied intermittently for a few hours daily, will represent the kind and amount of assistance necessary; instead of complete occlusion and by continuous pressure, which might lead to obliteration of the artery. This, the old method of compression, as employed by Dubois and Pelletan, has been judiciously superseded by the more conservative modification introduced by the Dublin school, and with which the names of Bellingham, Hutton, Tufnell, and Carte are principally associated. Compression is the means employed in either case; but the old method was simply blind empiricism, the modern one is a strict imitation of the mode of natural cure.

Fig. 114.



Instrumental Compression.—Various forms of Instruments have been devised for compressing an artery, above the seat of aneurism. The *compressor* used may be in the shape of the horse-shoe or Signoroni's tourniquet (Fig. 114); or that invented by Carte (Fig. 115), the advantage of which is that it provides an elastic and yielding pressure, instead of the unyielding force of the screw. Before applying this or any compressor, the limb should be evenly bandaged, to prevent congestion of the vessels, as much as possible; and the irritation occasioned by the pad of the instrument may be much prevented, by shaving and powdering the integuments of the part. The *degree* of compressing force appropriate should be estimated by its effect in controlling the pulsations in the aneurism; it being only necessary to suspend them, without entirely arresting the transmission of blood. The total *dura-*

Fig. 115.



tion of intermittent compression requisite, may be determined by its effect in promoting coagulation and consolidation of the tumour; the period necessary for this purpose varying considerably, from a few days to some months. In 26 successful cases, collected by Mr. J. Hutchinson, this period ranged between 60 hours and eight months; its average duration being 19 days. I have failed in arresting the enlargement of poplitial aneurism by compression, after a trial for two months; and then having had recourse to ligature of the femoral artery, an uninterrupted recovery has ensued in three weeks.

No medicinal treatment is indispensable to the completion of the process of cure, when thus induced by compression. If, notwithstanding the precaution of shaving and powdering the part, pain be occasioned by the pad in such degree as to disturb sleep, then indeed opiates may be administered; but, in most cases, this inconvenience will be anticipated by proper management of the instrument. It is well to try it on gently at first, and augment the pressure by little instalments; also to shift the pad from place to place in the course of the artery; and, as Tufnell suggested, to lighten it slightly, so that when the patient has fallen asleep, the pressure may be renewed without awakening him. This plan of treatment being a faithful imitation of the process of natural cure by retardation of the passage of blood through an aneurism, it is not surprising to find that the anatomical condition induced is the same as that resulting from the unaided process. In both cases, the aneurism is solidified and partly absorbed, leaving the artery pervious; while collateral branches proceeding from the parent trunk are enlarged, thereby contributing to maintain the circulation and nourishment of the limb below the seat of aneurism. Thus, during compression of the femoral artery, for popliteal aneurism, three arteries are observed to undergo enlargement; one passing over the centre of the tumour, another externally, over the head of the fibula, and a third internally, along the inner margin of the patella. This observation, originally due to Tufnell, is corroborated by Mr. Erichsen.

The *statistical* results which appear most worthy of credit, with respect to compression as practised in England, are those collated by Mr. Hutchinson from the Metropolitan and Provincial Hospitals. Of 70 cases, 46 were popliteal aneurism, and in 24 of them this treatment was successful. The remaining 22 cases had reference to the treatment by ligature of the femoral artery, as compared with compression. The experience of the Dublin Schools is far more favourable. Of 25 cases collated by Bellingham, in 1 only was the ligature subsequently resorted to.

The only disqualification of instrumental compression for the treatment of aneurism is its *impracticability* in certain parts of the body. It is almost necessarily restricted to the treatment of femoral and popliteal aneurisms.

Direct compression of the aneurism was formerly practised, with the view of opposing the *expansive* force of the current of blood and consequent enlargement of the sac. But pressure thus applied, not being designed to check the force of the current *through* the aneurismal portion of artery, was an unpathological mode of treatment; and, moreover, it was apt to cause inflammation and sloughing of the sac. This modification, therefore, which was first employed by Bourdelot, and

adopted by Guattani, Heister, and other Surgeons, not unsuccessfully, at length gave way to compression on the cardiac side of the artery.

Digital compression, or pressure with the fingers, may be conveniently applied to aneurisms in situations ineligible for instrumental compression. They are chiefly those of the axillary, subclavian, and carotid arteries. In these situations, pressure with the fingers on the cardiac portion of the aneurismal artery, will aid the natural process of cure by retarding the flow of blood through the sac. The requisite continuance of compression is provided for, by having a sufficient number of assistants; each, in turn, taking charge of the vessel before the previous one withdraws his finger, and observing to apply only that degree of pressure which controls the pulsations in the aneurism. Having maintained compression, in this way, for a few hours, the patient may be advantageously allowed a period of intermission, followed by its reapplication, and so on alternately. The total duration of these periods necessary to complete the cure, varies of course in different cases. In 19 cases successfully treated by digital pressure, the average number of hours was not more than $41\frac{1}{2}$; spread, however, over a variable period of time, owing to intermissions of the pressure. Whereas, according to the most favourable reports of those who are greatly interested in the treatment by instrumental compression, the average duration of treatment by that method was $20\frac{1}{4}$ days in each case.

Digital compression, for the cure of aneurism, is of quite recent date as compared with instrumental compression. In 1846, Professor Vanzetti first attempted it for the cure of a popliteal aneurism, at the Hospital of Karkof, in Russia. The case was deemed unsuccessful after only two days' treatment, and forthwith a ligature was resorted to. The particulars were not published until 1858. Meanwhile, in 1848, Dr. Knight, of Newhaven, United States, for the first time, successfully employed digital compression, as the sole means of cure, in a case of popliteal aneurism, and which had resisted compression by every kind of instrument. At the end of 48 hours' pressure, thus applied to the femoral artery, the tumour in the ham had become one-third smaller, hard, and pulseless. The treatment was then discontinued, and four months subsequently the tumour could scarcely be felt. Encouraged by this and similar cases, digital compression has since been on its trial, and this method now bids fair to rival instrumental compression. It is more simple, comparatively painless, a more speedy cure, equally effectual, and as permanently so.

Compression by *flexion* is another, and even yet more simple, method of pressure; but limited in its applicability to aneurism situated in the flexure of a joint. Thus, the cure of popliteal aneurism may be effected, simply by flexing the leg on the thigh and securing it in that position by a bandage, previously rolled round the limb from the toes upwards to prevent congestion. The degree of flexion requisite is an acute angle in the first instance; or better, a right angle only, at first, and gradually diminished. The duration of genuflexion necessary can scarcely yet be averaged. In the first successful case on record, that by Mr. Ernest Hart, the cure was considerably advanced after the first day, and complete on the fourth; on the seventh day the patient was moving about. In a case by Mr. Shaw, the cure was far more protracted, the cessation of pulsation not having been observed

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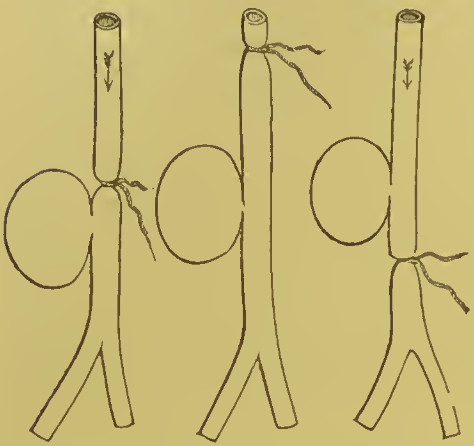
until the thirtieth day; but in this instance the tumour was of larger size. Many cases also are reported in which flexion has been successfully used in combination with pressure; one by Mr. Pemberton, another by Mr. A. Pritchard.

(2.) *Ligature.*—(*a.*) Ligature of the aneurismal artery on the *cardiac* side, and at *some distance* from the sac, in a *sound* portion of artery. This is the Hunterian operation for Aneurism. (Fig. 116, middle figure.) The application of a ligature to any part of an aneurismal artery, divides the vessel when the ligature separates; thus permanently intercepting the transmission of blood through the artery, itself perhaps a main trunk. This treatment, therefore, should be an ulterior resource to temporary compression, in any form; obliteration of the vessel not becoming necessary until after temporary compression—preceded by hygienic (and medicinal) measures, for retarding the general circulation—has failed.

Fig. 116.



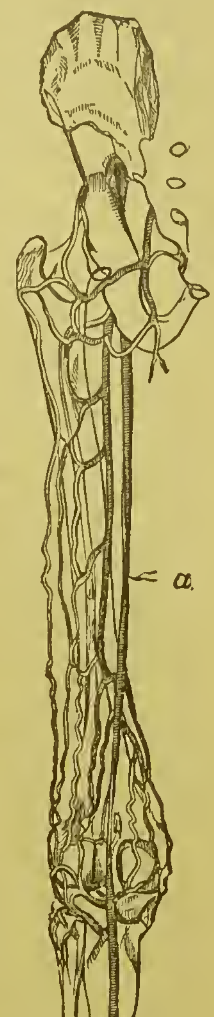
Ligature on the cardiac side of an aneurismal artery, as a surgical procedure, is another illustration of treatment in accordance with the mode of natural cure by retardation of the current through the aneurismal artery; but it is a further concession of such assistance. I have, therefore, postponed the consideration—as in practice, the application—of compression by ligature, until after that of other handy modes, without any surgical operation, have been tried and found wanting. Then, if the heart be competent to withstand the obstruction to the circulation consequent on the operation, and no internal aneurism complicate the case,—under these *favourable* circumstances, obliteration of the aneurismal artery, by ligature, is a justifiable resource.

There are, however, certain *unfavourable*, if not positively contra-indicating, circumstances with respect to this ulterior measure. Ossification of the artery at the seat of ligature would be a decidedly adverse condition. But this can scarcely be discovered prior to operation. A rapidly enlarging aneurism is unfavourable, as evincing an indisposition to the deposition of laminated fibrine. Then again, a very large aneurism is unpropitious, as threatening gangrene of the limb; an event almost inevitable, if the circulation were suddenly cut off by ligaturing the artery. Inflammation of the sac will be unfavourable, by possibly proceeding to suppuration; and suppuration itself would be a positively forbidding condition, by rendering the result of ligature abortive.

The Hunterian operation, first performed in December, 1785, consists in applying a ligature, on the cardiac side of the aneurism, to a *sound* portion of the artery; and therefore at some distance above the aneurism. For popliteal aneurism, the superficial femoral artery is ligatured, where this vessel is crossed by the sartorius muscle, in the middle third of the thigh. The force of the current of blood having

been thus reduced, coagulation within the sac is promoted, yet without cutting off the supply of blood entirely. A sufficient quantity is transmitted for the process of coagulation, by collateral branches issuing from the artery above the ligature and communicating with the vessel below, but above the aneurismal sac; while there is also a sufficient quantity of blood transmitted onwards, and by collateral branches which become adequately enlarged, for the maintenance of the limb below. (Fig. 117.) Meanwhile, coagulation and the deposition of laminated fibrine is proceeding in the aneurismal sac, and it extends into the artery as high, perhaps, as the ligature; both the sac and this portion of the artery thus become consolidated; the ligature separates, in the usual manner, by sloughing of the ring of artery within the noose, and the divided ends of the vessel are simultaneously sealed with plastic lymph. This takes place in a period ranging from ten days to a month; but varying chiefly according to the size of the artery, and the plastic power of the individual. Of 54 cases recorded by Crisp, in which the femoral artery was ligatured, the average period for the separation of the ligature was 18 days. Finally, the consolidated aneurism and artery are partially absorbed, so that the latter withers and degenerates into a fibrous cord. The limb, nourished by the collateral circulation, may nevertheless become somewhat atrophied.

Fig. 117.*



(*b*.) Anel's operation, 1710, contrasts with the Hunterian, in its ultimate *purpose*, more than as an operative procedure.

The operation proposed by Anel was to ligature the aneurismal artery, on the cardiac side, but *close* to the aneurism. (See Fig. 116, left figure.) The aneurismal blood escaping through the distal portion of artery, the sac would, it was thought, collapse, and thus the tumour disappear. For this purpose, the blood must remain fluid in the aneurism, instead of undergoing coagulation and the deposition of laminated fibrine, with occlusion of the sac, followed by the absorption of both, the tumour disappearing in that way. Although, then, these two operations are somewhat similar, they differ widely in their ultimate purpose as to their modes of cure. Moreover, Anel having performed his operation once only, and for traumatic aneurism of the brachial artery at the head of the elbow, he never himself repeated it, nor advocated its repetition, in similar cases. He apparently regarded his operation as applicable only in that particular case; unlike Hunter, as a *conception* ruling the treatment of a large class of cases.

It is, however, with reference to *idiopathic* aneurism—as implying a diseased state of the artery—that the operations of Anel and Hunter notably contrast, and when compared with the old operation which had been designed for the cure of such aneurism.

* From Liston.

The *old* operation, or that of Antyllus, consisted in extirpating the aneurism. An incision was made throughout the whole extent of the aneurismal sac, in order to scoop out the coagulum and expose the two orifices of the artery leading into the sac; immediately above and below those points a ligature was passed round the vessel, securing it in both directions. But an *unsound* portion of artery was thus selected —that immediately above and below the sac, which participated in the degenerative change of structure that originally gave rise to the aneurism. Hence, secondary hæmorrhage, perilous or perhaps fatal, generally occurred when either ligature separated, and as often necessitated amputation; while invariably, the large wound of the aneurismal operation healed tediously and often precariously to life by exhausting suppurative discharge. In Hunter's operation, a *sound* portion of artery was selected, thus avoiding these evil consequences. This operation, therefore, at once superseded that of Antyllus, and Anel's also—the ligature having been applied equally close to the aneurism in that operation. But the principle of Hunter's operation, in relation to the *natural cure* of aneurism, differed even more essentially from both these operations; in the assumption that it was necessary only to reduce the force of the circulation by applying the ligature at some distance from the aneurism, for the process of natural cure to supervene, instead of entirely arresting the current of blood through the aneurism by ligaturing the adjoining portion of artery.

Signs after Ligature, by Hunter's Operation.—Certain alterations in the signs of aneurism attend or follow the Hunterian operation of ligature. The aneurism ceases to pulsate and partially subsides. These changes taking place immediately the ligature is drawn tight, are valuable signs of its successful application. The circulation of blood being proportionately arrested in the limb, it becomes numb and cold, and its muscular power is diminished. As the collateral circulation is established, these immediate effects disappear, and the temperature of the limb may rise above that of its fellow.

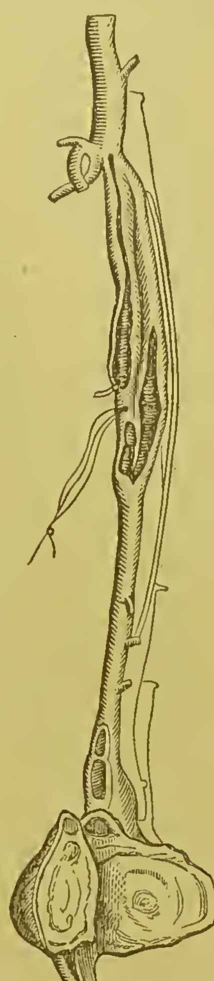
After-treatment.—The treatment *after* this operation should be directed to avert the temporary tendency to gangrene, pending the establishment of an adequate collateral circulation. Hence, the circulation and temperature of the limb must be maintained. A thick wrapper of carded wool answers most effectually, aided by a suitable elevation of the limb to relieve congestion. The diet should be moderately nourishing and stimulant, which, with the judicious administration of opium, will tend to sustain the process of cure.

Consequences.—Certain *unfavourable consequences* and evil *results* are liable to ensue from this application of the ligature for aneurism.

(1.) *Pulsation may continue or return* in the aneurismal sac. The small stream of blood conveyed by collateral branches into the artery below the ligature, and thence into the sac, depositing the laminated fibrine, is not a pulsatory current. If, however, these feeding vessels are larger than sufficient for this purpose, pulsation continues, or soon returns; if they enlarge immoderately, then also pulsation returns. Any regurgitation of blood into the sac, from below, and therefore in opposition to the current, need scarcely be taken into account. If it occur, it will cause gradual enlargement of the aneurism without pulsation; simulating the gradual increase of a malignant tumour. Rarer causes are these:—Any condition of the blood which, delaying or

hindering coagulation, disposes it to remain fluid in the sac, will favour the continuance of pulsation. A vas aberrans may exist, which communicating directly, or indirectly, with the aneurism, thus continues its pulsation. An instance of this kind occurred to Sir Charles Bell. He ligatured the femoral artery for popliteal aneurism. The patient died a week afterwards from erysipelas; and it was then discovered that the femoral artery was double, and that the vas aberrans had continued to supply blood to the aneurism in the ham, after the operation. Yet in this case, the sac had become completely consolidated with coagulum, and in the short period of one week. The preparation is in the museum of University College, London; and the instructive lesson it conveys will be further impressed by the engraving. (Fig. 118.) Other contingencies, by which the pulsation of an aneurism continues after the application of a ligature, relate to the operation. The ligature may not have been applied to the aneurismal artery; or having been applied thereto, the noose may have been tied obliquely, instead of transversely, then shifting its place and loosening its hold, the pulsation continues, or returns, soon after the operation.

Fig. 118.



Of all these causes of pulsation after the Hunterian operation for aneurism, that arising from an undue collateral circulation, as explained, is by far the most common. But it occurs with different degres of frequency in different arteries. In carotid aneurisms it is most frequent. Of 31 cases, in which the carotid artery was ligatured for aneurism, pulsation continued or returned in nine; whereas of 92 cases of inguinal aneurism, in which the external iliac artery was ligatured, pulsation returned in six cases only. In axillary and popliteal aneurisms, respectively, recurrence of pulsation is an exceptional event.

It should be remembered that a slight thrill may very frequently be felt in an aneurism, on the second or third day, after the application of a ligature by the Hunterian method. This, however, is a favourable occurrence, as it bespeaks a feeding stream of blood for coagulation in the sac; and it supervenes with about equal frequency in all aneurisms, irrespective of any particular portions of the arterial system, and the distribution of vessels accordingly. The thrill, thus arising, soon subsides—with consolidation of the sac. Returning pulsation, on the other hand, if it occurs, usually begins at a much later period, not until a month or six weeks have elapsed, and continues for some time.

Returning pulsation is seldom persistent, and rarely terminates fatally. Of 26 cases in which pulsation returned, three only were fatal, and then not owing to this event, but by sloughing of the sac.

(2.) *Secondary* Aneurism, or aneurism reappearing by *redilatation* of

an aneurismal sac, which had previously undergone consolidation and absorption, is an extremely rare event. This must not be confounded with returning pulsation. Mr. Erichsen believes there are only two unequivocal instances on record, both of which were in the ham; the original tumour having disappeared entirely, this secondary disease made its appearance after the lapse of six months in one case, and after four years in the other instance. Secondary Aneurism, in the sense of another *distinct* aneurism arising close to the former one—double aneurism, in fact—is quite another matter.

Treatment of Pulsation, Continuous or Returning.—This, of course, must have reference to the cause or causes of the pulsation. Arising, in most instances, from an undue collateral circulation communicating, directly or indirectly, with the sac, the pulsation will cease as the deposition of laminated fibrine proceeds therein. The process of natural cure rights itself. Failing this result, the balance between the deposition of fibrine and the supply of blood may be slowly gained, or regained by sufficiently elevating the limb; while the pulsation can be directly restrained by moderate pressure on the aneurism, with a compress and roller, evenly applied. These resources not proving effectual, the coagulating power of the blood deserves consideration; but our knowledge respecting its operation within the body is at present very limited. Here then pathology fails to guide the treatment. The presence of a vas aberrans is discovered at the time of operation, by ascertaining whether the ligature *entirely* controls the pulsation of the aneurism. If not, the tributary vessel should be sought. It will not be far off, and it must be secured by another ligature. In like manner, the aneurismal artery is *identified* by trying the pulsations of the sac, when the supposed aneurismal vessel is commanded above; but this should be done *before* the ligature is applied. Lastly, application of the ligature *transversely* round the artery will avoid any chance of pulsation continuing or returning, as occasioned by shifting of the noose.

Extreme cases, which baffle all these resources and precautions, necessitate further operative proceedings. *Reapplication* of the ligature may have to be resorted to; either lower down the artery—nearer the sac, as an approach to Anel's operation—or by opening the sac, turning out the clots, and tying the artery immediately above and below—the old operation of Antyllus. I know of no *data* for determining the Surgeon's choice, but the latter operation, whereby Nature's work of coagulation and consolidation is undone, should be resorted to reluctantly. *Amputation* is the very last resource.

(3.) *Gangrene of the limb* proceeds from causes of an opposite character to those which induce pulsation in the aneurism, after the Hunterian operation. The latter are conditions which favour an undue collateral circulation through the sac; the conditions to which I now allude retard any collateral circulation. *Firstly*, an aneurism itself retards the current of blood through the artery, and operates also by compressing the neighbouring vessels; thus preventing the transmission of arterial blood, and the return of venous blood. Gangrene threatens. The application of a ligature to the aneurismal artery is an additional obstruction, rendering the condition more perilous; and if the collateral circulation be interrupted by the large size of the aneurism compressing the neighbouring vessels, then gangrene ensues. *Secondly*, surgical mismanagement of the limb,

after operation, by inattention to position and temperature, or the presence of any morbid condition which lowers the vitality of the limb, will severally tend to induce gangrene.

It supervenes in a period varying from the third to the tenth day; but in rare cases, not until the third week. (Porter.)

Treatment.—So far as gangrene is due to the ligature, it cannot be prevented; but if due principally to interruption of the collateral circulation by pressure of the sac, this source of obstruction can be removed by the old operation of cutting down upon the sac, laying it freely open, and turning out the clot. At least two such successful cases, both of popliteal aneurism, are on record; one by Lawrence, another by Benza. Other preventive measures, topical, dietetic, and medicinal, have already been noticed in reference to the appropriate treatment after ligature. With gangrene, as with recurring pulsation, amputation of the limb is our last resource; and the operation must be performed above the situation of the ligature.

(4.) *Suppuration and sloughing of the sac* is attended with the usual symptoms of inflammation—heat, pain, and throbbing. At length the integuments give way, and portions of clot escape, having various degrees of consistence and shades of blood-red colour. Then hæmorrhage of fluid arterial blood occurs, either with a fatal gush, or recurring in small but increasing quantities. Which form of hæmorrhage shall take place is apparently determined by the degree to which consolidation of the aneurism has advanced; and therefore, in a measure, by the time of its occurrence after ligature. The amount of hæmorrhage is regulated in like manner, it being most free and uninterrupted in the event of pulsation continuing or returning.

The *causes* of suppuration and sloughing of the sac, and of hæmorrhage thence arising, in the course of aneurism, are any conditions unfavourable to the vitality of the sac. Hence, the large and increasing size of an aneurism, and the imperfect coagulating power of the blood therein, have this tendency. So also any external injury to, or irritation of, the sac. Considering these and other similar accidental circumstances, the period after ligature when suppuration may supervene is, obviously, very uncertain. It may happen at any time in the subsequent course of the aneurism. The average time is, perhaps, between the third and eighth weeks, but in a case of carotid aneurism recorded by Sir A. Cooper, suppuration occurred at the eighth month after operation. Comparatively few cases terminate fatally; probably not more than one in four, and then, generally, by hæmorrhage.

Treatment.—This will be guided by the state and result of suppuration. In the first instance, the sac should be treated as an ordinary abscess; only that when an incision is made, it should be free enough to turn out the whole of the clot. I did this with a successful result in the case of a popliteal aneurism, the sac having suppurated after ligature of the femoral. Any remaining portion of coagulum is likely to putrify and become a fœtid, purulent discharge; but when removed entirely, the sac is in a condition to heal from the bottom by granulation. *Hæmorrhage*, of course, is imminent. A tourniquet, therefore, loosely applied to the limb above, will be a judicious precaution which can be brought into use at any moment. In the event of hæmorrhage, loss of blood may be *temporarily* stayed by a compress of sponge well

placed at the bottom of the sac, over its mouth; and of sufficient size to be secured in position by a roller, evenly applied. Then comes the question of how to *permanently* arrest the hæmorrhage? The diseased state of the artery immediately above and below the sac, in idiopathic aneurism, forbids the application of a double ligature *in situ*, as by the old operation. Ligature of the artery higher up than was performed prior to suppuration, would probably be the turning-point for the commencement of gangrene. In this dilemma, the Surgeon may advantageously wait and see what Nature can accomplish, as the healing process of granulation closes over the arterial aperture in the sac; guarded always by the compress, and during its reapplication occasionally, by tightening the tourniquet.

This faithful following up of Nature's operation having failed, our only resource is amputation.

5. *Secondary hæmorrhage* from the operation-wound, after ligature by the Hunterian method, is an event unconnected with the course of Aneurism. It is a failure of the operation; and, as it arises from sloughing of the included portion of artery before the preparatory closure of either or both ends of the vessel has taken place, the hæmorrhage occurs whenever the ligature separates. The average time was the eighteenth day, in 54 cases, recorded by Dr. Crisp, of ligature applied to the femoral artery. It is more likely to occur, the nearer the artery is to the heart, the central force of the circulation.

The *treatment* in this case is not presumed to be restricted by any diseased state of the artery, at the seat of ligature. Consequently, the reapplication of *two* ligatures, one to each end of the artery at the point of division, will most probably prove effectual; the former operation-wound having been just sufficiently reopened for this purpose. Temporarily, the hæmorrhage may be arrested or checked by plugging with sponge or lint.

Statistical Results.—Ligature for Aneurism shows a considerable mortality. In 256 cases of this operation on the larger arteries, the deaths were about 22 per cent. This was shown by Dr. Crisp's tables. The result of investigations by Porta is even more startling. In 600 cases of ligature for diseases and injuries indiscriminately, the mortality rose to 27 per cent. Then again, as compared with *compression*, the balance is decidedly in favour of the latter mode of treatment. Thus, according to Norris, of 188 cases of ligature for femoral and popliteal aneurisms, 142 were cured, 46 died, 6 limbs were amputated; in 10 suppuration of the sac supervened, and in 2 gangrene of the foot; giving a total of deaths about 1 to 4, and failures 1 to 3. Whereas of 32 compression cases, also of femoral and popliteal aneurisms, collected by Bellingham, 26 were cured, in 1 ligature was resorted to after compression had failed, in 2 amputation became necessary, in 1 death occurred from erysipelas, in 1 from chest-disease, and in 1 instance the pressure was discontinued. The failures of compression were, therefore, only as 1 to 5·3; and the deaths only as 1 to 16. Even where compression itself fails, it most advantageously prepares the way for success by ligature. Thus, according to Mr. Hutchinson's Report, in 22 cases of ligature of the femoral artery, previously treated by compression,. 2 only died of gangrene; whereas, in only 10 such cases, without preparatory compression, 3 deaths occurred from this cause.

Obliteration of an Artery without Division.—Since the period of John Hunter, whose method of operation, on the femoral artery for the cure of poplitcal aneurism, originally consisted in the compressing application of a ligature, or ligatures, without any division of the coats of the vessel, this principle of treatment has, from time to time, attracted attention; the object being the consequent preservation of the continuity of the artery, thus to prevent the risk of secondary hæmorrhage. Various procedures and contrivances have been devised for this purpose. Thus, temporary compression of the exposed artery, as by means of Assalini's compressor, Crampton's *presse-artère*, or Porter's wire-compressor, improved by Stokes, an instrument whereby acupressure is effected; or ligature has been used, but made of silver wire, or consisting of some animal substance, such as chamois leather, introduced by Dr. Physick, of Philadelphia; buck-skin thread, employed by Dr. Jamieson, of Baltimore; or moistened catgut, which was the material, as first suggested by Sir A. Cooper, and subsequently preferred in Porta's practice. Animal ligatures are cut off short, and left in the wound, which heals over them; any such ligature is better tolerated as a foreign body, and it may possibly become absorbed, leaving the external coat of the artery undivided, but the vessel obliterated. *Carbolised* catgut—a more recent appliance, in accordance with Lister's antiseptic principle of treatment—seems to answer even better; the wound almost always healing by primary union, and burying the ligature. Arteries of the largest size, as the common iliac, external iliac, femoral, common carotid, and brachial arteries, have been deligated with animal ligatures; as by Porta and Bickersteth, both of whom used catgut.

The *results* of this method of treatment, by ligature, have been encouraging; that—as Mr. T. Holmes has shown—arteries may be tied and obliterated, but without their continuity being interrupted, thereby affording much security against secondary hæmorrhage; while the wound heals by primary union. On the other hand, failures in both respects must not be overlooked; the artery becoming divided, as after ordinary ligature, and the wound opening up with abscess and discharge.

iii. *Manipulative* and *Operative* resources, corresponding to the *second* mode of natural cure—*i.e.*, retardation of the passage of blood, through the aneurism, by obstruction of the *distal* portion of artery; a piece of clot being dislodged from the sac and washed into the mouth of the distal portion, or becoming impacted within it, some distance off.

(1.) *Manipulation.*—This plan of treatment was introduced by Sir W. Fergusson. It consists in so thumbing the aneurism as to dislodge a piece of clot into the distal portion of artery. The manipulative procedure designed for this purpose is thus described: "The patient was seated in a chair, and I placed the flat end of my thumb on the aneurismal tumour so as to cover the prominence. I then pressed, until all the fluid blood had passed from the sac, and I could feel that the upper side of the aneurism was pressed against the lower. I now gave a rubbing motion to the thumb, and felt a friction of surfaces within the flattened mass. The movements were little more than momentary, but they were such as I had preconceived." Two cases of subclavian aneurism were subjected to this treatment; neither was unequivocally successful, and both were attended with very alarming symptoms at

the time of manipulation. In the first case, the aneurism never ceased to pulsate, and, after eight months, terminated fatally by rupture of the lower and back part of the sac. The axillary artery was found to be firmly plugged with fibrine. In the second case also, the aneurism continued, but the pulse ceased at the wrist. At the end of two years, and after hard work as a sailor, the aneurism itself had disappeared. In both cases, giddiness and faintness were immediately produced by the manipulation; and in the second case, these symptoms were succeeded by hemiplegic paralysis of the left side, from which, however, the patient recovered in two months.

So far the results of treatment by manipulation were not very encouraging. More disastrous cases occurred in the hands of Esmarch and Teale, of Leeds. Both were carotid aneurisms. On the other hand, an aneurism of the right subclavian artery, thus treated by Mr. R. Little, proved quite successful, although not without the disadvantage of temporary paralysis of the arm. Two successful cases in aneurism of the lower extremity, one of the femoral artery, treated by Dr. G. E. Blackman, of Cincinnati, and the other of the popliteal artery, by Mr. Teale, are, I believe, the only additional results, at present, in favour of this method of treatment.

(2.) *Compression*, or *Ligature*, of the *distal* portion of an aneurismal artery represents other methods of imitating the second mode of natural cure; although the obstruction, as thus effected, is not by the impaction of a piece of clot in that portion of the vessel. The operation by ligature of the distal portion is principally associated with the names of Brasdor and Wardrop. (See Fig. 116, right figure.) Whether the arterial current be obstructed by ligature, or simply by compression of the artery, at that part of its course, in either case the principle is to retard the stream of blood *through* the aneurism, and thus induce the deposition of laminated fibrine with consolidation of the sac. For this purpose, it is necessary that there shall be no arterial branch between the aneurismal sac and the ligature, which would lessen the obstruction offered to the current of blood on the distal side of the sac. Carotid aneurism alone fulfils this requisite condition for the success of distal ligature or compression.

The immediate effect of distal obstruction is to turn the full force of the arterial current into the sac; which being distended, may at once yield and burst with fatal hæmorrhage. Should this issue not occur, the collateral branches of artery from the main trunk above the aneurism, will probably have time to enlarge sufficiently to carry on the circulation for the maintenance of the limb; a small feeding stream of blood passing down also to the sac, which becomes solidified and obliterated by the process of natural cure. But this happy issue is very precarious and doubtful. According to the results of 27 cases collected by Mr. Erichsen, 20 terminated fatally soon after the operation, and in the other 7 cases, although the patients survived the effects of ligature, the disease remained uncured.

iv. Certain *Operative* procedures, of a *physical* or *chemical* character, correspond to, if they do not imitate, the *fifth* mode of natural cure; that by inflammation of the sac, and its consequences. *Galvano-puncture* has been practised for the purpose of inducing coagulation of the blood, *en masse*, within the sac. Two needles, insulated by gutta percha coating, and connected with the wires of a galvanic battery, are

introduced into the sac, in opposite directions, until they touch, and fibrine becomes deposited around one of the poles, or needles. The action of the battery should be continued for about ten minutes, and repeated several times.

Under this galvanic influence, a soft clot may form which partially fills the sac; but acting as a nucleus it may induce the deposition of laminated fibrine, and at length occupy the whole sac. Or, a large but loose clot having formed, in the first instance, it may settle down, and thus the sac become consolidated. Or lastly, the current of electricity excites inflammation of the sac, rather than coagulation of its contents; and this may be followed by coagulation, or by suppuration with sloughing of the sac and its obliteration. These are successful issues. But there are cases, and not a few, of an opposite kind. The clot liquifies, pulsation is re-established, and the disease resumes its course. This relapse, after galvano-puncture, is probably due to the mode of coagulation thereby effected; the mass of blood setting suddenly into a semi-solid state, instead of consolidating by the gradual deposition of laminated fibrine. Then again, in the event of inflammation supervening, sloughing is mostly accompanied with hæmorrhage which may be fatal to the patient's limb or life. Apart from any adverse issue, the pain occasioned by galvano-puncture is always hard to bear, in some cases intolerable; and the administration of chloroform would probably be injudicious.

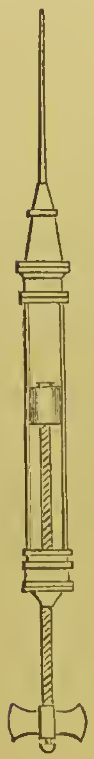
Galvano-puncture is of comparatively recent date. First introduced by Mr. B. Phillips, in the year 1832, it was subsequently followed up by Liston, Gerard, and Keate; but with so little success that it fell into disuse. A few years later, however, this proceeding was practised by Pétrequin and Burci with more success, and thence its revival as an occasional expedient. It is justifiable only, or chiefly, in cases of internal aneurism, or of aneurism at the root of the neck; in fact, where compression, ligature, or any other method of treatment has failed, or is impracticable.

The *statistical results* hitherto recorded are very unfavourable. According to Bonnet, up to July, 1851, 23 cases of aneurism had been subjected to this treatment; 8 were of the brachial artery, 7 of the popliteal, 2 of the subclavian; 1 of each of the following arteries—ophthalmic, temporal, carotid, thoracic aorta, ulnar; and 1 unknown. Of these, 13 cases were unsuccessful, and although 9 were reported as successful, 7 of them were due rather to compression and the application of ice, or to inflammation and suppuration of the sac, than to galvano-puncture. It failed, therefore, in no less than 20 cases out of 23; leaving only 2 favourable results, excluding the unknown case. Subsequently, out of 50 cases collected by Ciniselli, 23 were cured, 20 were not cured, and 7 were fatal. I have resorted to galvano-puncture in a case of subclavian aneurism, to which I shall again refer; but the effect produced was slight and only temporary. Mr. Holmes concludes, respecting this method of treatment, that "its use is not so dangerous as to render further trials of it inexpedient," and he anticipates that it may be so far perfected as to become "a safe and regular plan for the treatment of thoracic, subclavian, and other forms of aneurism."

The injection of coagulating agents has been practised, like galvano-puncture, with the view of inducing coagulation, *en masse*, within the

sac. Various such agents have been tried. The least hazardous, and the most efficacious, appears to be a weak solution of perchloride of iron, used in small quantity. A solution of 20° Beaumé, is the highest degree of strength recommended by Valette; and twenty drops only to every 100th of a pint of the blood in the sac is the quantity permitted by Broca. The safest instrument for injecting is a small glass syringe, furnished with a screw-piston, and a fine-pointed nozzle—the hypodermic syringe. This instrument may be graduated, so as thus to regulate the quantity of fluid injected by means of a sliding piston; but a screw-acting piston answers the purpose more exactly, one turn of the screw corresponding to a minim of the solution. Before introducing it, the circulation through the artery should be suspended by compressing the vessel carefully on either side of the aneurism. Then the point should be thrust perpendicularly into the aneurism, until a drop or two of arterial blood escaping, shows that it has penetrated. The instrument may be directed to different points within the sac, and a drop or two deposited successfully, forming as many centres of coagulation. On withdrawing the instrument, a turn of the piston, backwards, will prevent any of the solution escaping under the integument.

Fig. 119.



Taking all these precautions, as to strength and quantity of the solution, and its injection into the sac alone, coagulation may proceed to consolidation and cure. But the process may stop short of this issue; or inflammation be excited in the sac, which, owing to the highly irritating character of the solution, will probably result in suppuration and sloughing, with fatal hæmorrhage, or by extending to the surrounding integuments, may end in gangrene of the limb. Thus, then, the probable consequences of this treatment restrict its eligibility; while the kind of coagulation induced, *en masse*, disqualifies it proportionately, for the cure of aneurism. Then, again, the requisite compression of the artery on the cardiac and distal side limits the applicability of injection to aneurism in certain situations only. Internal aneurisms are excluded; and external aneurisms — those of the extremities—are open to far preferable methods of treatment—compression or ligature.

Injection seems to have been practised indiscriminately, or at least without regard to the situation of the aneurism. Originally suggested by Monteggia, injection was tried, with different coagulating agents, by Vilardebo, Wardrop, Leroy d'Etiolles, Pravaz, and Pétrequin. Aneurisms in every part of the body have been subjected to this treatment; those of the innominate artery by Barrier; of the subclavian by Pétrequin; of the carotid by Dufour; and of the popliteal artery by Wiepec, Minor, Isaacs, and Lenoir. Aneurism of all-sized arteries has been injected, from that of the supra-orbital artery, by Raoult and Deslongchamps, to the aorta itself, by Syme. The sum total at present exceeds thirty cases. But their results have not been sufficiently analyzed to draw any numerical conclusion for, or against, this kind of treatment. Injection succeeds in so far as it induces *coagulation*, rather than excites inflammation and its consequences. Such also is the favourable *modus operandi* of galvano-puncture.

Treatment of Traumatic Aneurism.—The requisite operative procedures here also are governed by the pathology of this lesion.

In the first instance, traumatic aneurism is always a *diffused* and more or less pulsating collection of blood, communicating with an artery; this escape of blood having taken place, by a puncture or laceration, more or less complete, of the vessel; and with, or without, an external wound of the integuments. Such being the essential condition of traumatic aneurism, if the tumour be also enlarging, if it be diffused and *diffusing*, the immediate and total arrest of the hæmorrhage is necessary. For this purpose, no partial arrest of the current through the wounded artery, no mere retardation of the passage of blood, will suffice, as for idiopathic aneurism, in its early or circumscribed state. The *whole* force of the circulation through the artery must be taken off, ere the hæmorrhage will cease, and the diffused aneurismal tumour cease to spread.

Ligature, therefore, of the artery *above and below* its wounded point is the treatment indicated. This, however, is easier said than done, in most cases. A free incision into the tumour will expose the half-coagulated blood and commingled textures, when the mass can be readily turned out; the recurrence of hæmorrhage during this procedure being guarded against, by an assistant compressing the artery on its cardiac side, and as near the tumour as is practicable. Having sponged the bottom of the cavity thus made, the bleeding orifice may be seen at once, or it will be discovered by a spirt of blood, when compression on the artery above is slightly, and momentarily, relaxed. This is the point for which the Surgeon seeks. The vessel must then be secured, by tying it on either side of the aperture; or if divided, by tying both ends. Here especially, difficulty is encountered; owing perhaps to the locality of the artery, and also to its disorganized, although not degenerate state, as in idiopathic aneurism. Failing to effectually control the hæmorrhage, plugging of the cavity, from the bleeding aperture outwards, will be necessary to completely arrest it. And this additional safeguard is unobjectionable, as the wound can only heal, for the most part, by granulating from the bottom.

If a traumatic aneurism has become *circumscribed*, thereby evincing a decided tendency to natural cure, then indeed the lesion so far resembling an idiopathic aneurism, it may be treated accordingly, by merely retarding the force of the circulation through the aneurismal artery. *Compression*, therefore, of the artery *above* the aneurism, or perhaps *direct* compression; and *ligature* on the *cardiac* side only, and at *some distance* from the tumour—*i.e.*, the Hunterian operation—are both eligible resources. If the circumscribed aneurism be of *small* size, compression alone may prove sufficient to retard the passage of blood; or that failing, the Hunterian operation will probably be an effectual check. This operation is often far more conveniently performed than any application of a ligature near the tumour. Thus, in the palm of the hand, where it would be difficult and hazardous to apply a ligature on either side of an aneurismal tumour, the brachial artery has been ligatured for a small circumscribed traumatic aneurism over the ball of the thumb, and cure was accomplished.

The application of a ligature, still on the cardiac side alone, but *near* the aneurism, is not forbidden by any structural condition of the artery. This procedure—Anel's operation—is appropriate, provided

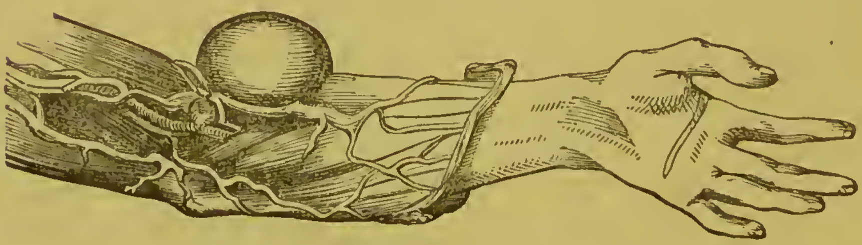
only that the force of the circulation through the aneurism can thus be sufficiently retarded. But if the aneurism be, or become, of *large* size, although circumscribed, the force of the current preponderates over the arterial resistance, and the balance cannot be sufficiently restored by a ligature at any part of the artery, on its cardiac side alone. The treatment accordingly is again restricted to double ligature —one on either side of the bleeding aperture—by the operation already described; the old operation of Antyllus, as for *diffused* traumatic aneurism.

The treatment of traumatic aneurism unaccompanied by an external wound, will be considered in connection with Complicated Fracture and Dislocation, respectively.

Aneurismal Varix and Varicose Aneurism.—*Structural Conditions.* —An opening between an artery and a vein, in contact, whereby a *direct* communication of the two vessels is established, constitutes Aneurismal Varix. (Fig. 120.) Through this opening, the current of arterial blood, being the more forcible, passes, in part at least, into the opposing current of venous blood. Under favourable circumstances— to be presently explained—an *indirect* communication is established, by the formation of an intervening circumscribed false aneurism; this condition constituting Varicose Aneurism. (Fig. 121.) It is so named from the varicose condition of the vein, with which the artery thence communicates. But the vein is varicose also in Aneurismal Varix.

Fig. 120.*

Fig. 121. †



Signs.—The same signs accompany either of these lesions, and they are very significant. Take, for example, a communication of the brachial artery and median basilic vein, occasioned by unskilful venesection; whereby both these vessels are punctured, as they cross at the bend of the elbow. The superficial aperture in the vein and skin may soon be healed, but the deeper aperture in the vein and that in the artery remain open. The current of arterial blood, being partly diverted from its course, is less forcible below the seat of injury, reducing the pulsation at the wrist to a feeble thread; and as the

* From Liston. † From Liston.

jetting stream passes through the median basilic vein into the veins of the forearm and arm, they become distended and tortuous, or varicose. The median vein, more especially, assumes an eel-like appearance down the forearm; while the median basilic and median cephalic, the radial and ulnar veins, with the basilic and cephalic veins at the bend of the elbow, also exhibit in various degrees the force of the arterial current; they all become enlarged and varicose. Aneurismal Varix simply, is formed as the result of the puncture of both vein and artery; or, the jet of arterial blood passing into the vein, may burrow for itself a cavity in the intervening cellular tissue; forming a circumscribed false aneurism, as the medium of an indirect communication between the two vessels, and constituting Varicose Aneurism.

In either condition, the *varicose* state of the neighbouring veins connected therewith, is the *earliest* and *most characteristic* appearance. The aneurismal swelling is wholly, or partly, formed, as the case may be, of enlarged and tortuous veins. And these veins, with or without the circumscribed aneurism, pulsate in unison with the arterial pulse; their pulsation being distinctly visible, perceptible also as a tremulous thrill, and audible as a soft, burring sound. Moreover, the whole swelling can be emptied by pressure upwards in the course of the veins, or it subsides and regains its former dimensions, when pressure is made on the artery. An elevated position of the limb will have the same effect. In the event of a circumscribed aneurism having formed, between the aperture in the artery and that in the vein, this portion of the swelling is at first soft and compressible, but it acquires a firmer and less elastic consistence, by the gradual deposition and consolidation of fibrine within the sac. If allowed to progressively enlarge, the skin shows the tint of venous obstruction, by assuming a livid hue; while the whole limb, downwards from the seat of injury, becomes swollen, œdematous, feeble, numb, and cold, even threatening gangrene.

Causes.—The communication between an artery and a vein is commonly of *traumatic* origin; as that produced by puncture in unskilful venesection at the bend of the elbow, or a lesion from the thrust of a sharp instrument, or a ball in gunshot wound, passing between an adjoining artery and vein. But an opening may result from a diseased condition of the vessels, the lesion having an *idiopathic* origin; as in the bursting of an ordinary aneurism occasionally into a neighbouring vein. The *determining* cause of Aneurismal Varix simply, or the formation of Varicose Aneurism, has reference to the anatomical relation of the artery and vein. Whenever the two vessels are in contact, a direct communication may be produced—giving rise to Aneurismal *Varix;* whenever the vessels are not in contact or in apposition, an indirect communication is established, by the formation of an intervening circumscribed false aneurism—constituting Varicose *Aneurism.* The latter is an additional condition. Aneurismal varix, or, perchance, *plus* the intervening aneurism, may be produced in various parts of the body; wherever a direct, or an indirect, communication can be established between an artery and vein of tolerable size. Therefore, with respect to the thigh, the ham, the neck, the arm, and in other situations, there are cases recorded. But the bend of the elbow, as already described, is the more common seat of these lesions, or it was so in the days of venesection.

Course, and *Consequences.*—Whether simply as Aneurismal Varix, or as Varicose Aneurism, the vascular condition may remain stationary for years. There are cases of varix on record, which remained without further inconvenience for fourteen, twenty, and thirty-five years. But in all cases, the *tendency* is to gangrene of the limb or part below the seat of communication between the artery and vein.

Treatment.—The more simple condition—*Aneurismal Varix*—requires treatment only in proportion to its progressive enlargement. In most cases remaining stationary for months or even years, and without any notable inconvenience, no remedial interference will be necessary.

The *prevention* of any further enlargement of the already aneurismally enlarged and tortuous veins should be the first consideration. Moderate pressure, applied over the aperture of communication between the artery and vein, will, generally, be a sufficient restraint to counteract any such tendency. A suitable compress should be worn, with an elastic bandage to support the veins below the aperture.

In exceptional cases, aneurismal varix undergoes *progressive enlargement;* at length attaining such a size as to endanger the limb by gangrene, or the patient's life by hæmorrhage. Then indeed it becomes necessary to entirely stop the transmission of blood from the artery into the vein. No partial arrest, no mere retardation of the arterial current, will avail. Compression, whether applied directly over the aperture, or indirectly to the artery above the varix, or the Hunterian ligature applied higher up, would, therefore, alike be useless. The transmission of blood can be entirely precluded only by cutting off all communication between the two vessels; namely, from above and below. Hence, the operation by double ligature of the artery, on either side of the aperture, is the only safeguard; the same as for a punctured wound of the vessel.

In the event of *Varicose Aneurism* having formed, this indication of treatment is the more imperative. A circumscribed false aneurism co-exists with the varix, and the sac has two apertures, placed also on opposite sides; thus freely transmitting a stream of blood continuously through the sac, and completely frustrating any tendency to the deposition of fibrine and spontaneous cure. Gangrene and hæmorrhage are both more imminent than in aneurismal varix.

Operation.—The application of double ligature under the circumstances of aneurismal varix, and of varicose aneurism especially, is attended with some difficulty. In either case, the considerable varicose enlargement of the vein, forming a fusiform pouch over the aperture in the artery, with tortuous eel-like communicating branches of vein above and below, and the dilatation of the artery itself above the aperture, together constitute a pathological condition which well-nigh effaces the mere surgical anatomy of, say, the bend of the elbow, in a case of aneurismal varix resulting from unskilful venesection. If an intervening aneurism be *superadded*, as between the brachial artery and median basilic vein, in the case supposed; if, in fact, there be a varicose *aneurism*, this pathological complication still further transforms the purely anatomical relations of the part. Thus, in performing the operation for double ligature, the first incision through the skin, and which lays open the venous pouch, brings into view a cavity, at the bottom of which an aperture is seen. But this is not the aperture for

ligature; it leads into another cavity, the intervening aneurism, which must now, in its turn, be laid open, at the bottom of which there is another aperture, opposite to the former one; and that aperture, leading into the artery, is the one, on either side of which the vessel must be secured The application of the ligature is often a proceeding of some difficulty also; owing to the dilatation of the artery on the cardiac side, and its equally contracted state below the aneurismal aperture. In an aneurismal varix from wound of the femoral artery and vein, Professor Pirrie found the former vessel enlarged to the size of a portion of small intestine.

Considering the difficulties of this apparently simple operation, it has been proposed, by Roux and Fergusson, to apply the ligatures without opening the sac.

The objection to any operation by double ligature is the risk that, in curing the lesion itself, gangrene or hæmorrhage will more probably supervene than when it is allowed to take its natural course.

Other kinds of treatment have been proposed, but less in accordance with pathology, and practised, therefore, with less success. Thus, *galvano-puncture* has proved effectual; in one case by Bosse, in another by Capeletti, but through suppuration; and a third instance of cure is recorded by Debout. The perchloride of iron *injection* was tried by Serres d'Alais, Jobert, Vallette, and Valpeau; in two cases only with complete success; in a third suppuration effected a cure; and a fourth case was altogether unsuccessful.

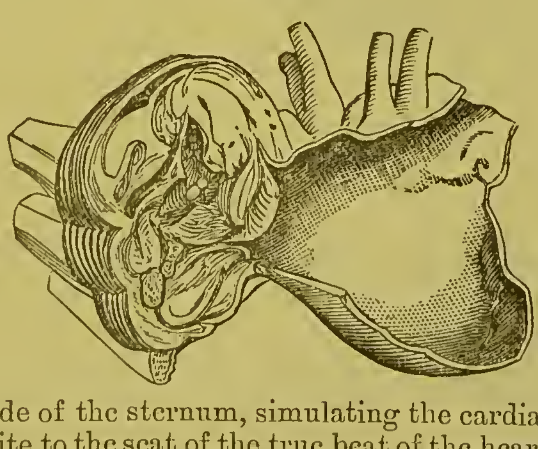
CHAPTER XXVI.

ANEURISM, IDIOPATHIC AND TRAUMATIC, OF SPECIAL ARTERIES.

Arch of Aorta.

Aneurism.—*Symptoms.*—In the *early* stage of aneurism affecting any portion of the thoracic Arch of the Aorta, the symptoms are singularly absent or equivocal. A bellows murmur, or an extension of the second sound of the heart over a certain area, with some dulness on percussion, may be the only discoverable symptoms to arouse suspicion. Any tumour or pulsation externally is quite imperceptible, excepting with reference to three portions of the arch.

Fig. 122.*

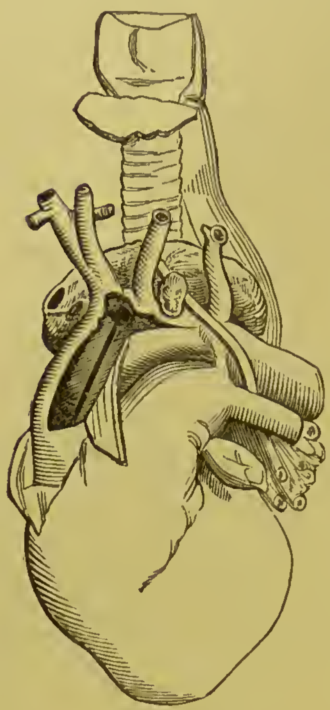


(1.) *The anterior aspect of the ascending aorta.*—Pulsation may be perceptible by pressure between the intercostal spaces on the right side of the sternum, simulating the cardiac impulse, in addition and opposite to the seat of the true beat of the heart. As the aneurism increases, a tumour presents externally. (Fig. 122.)

* Royal College of Surgeons, Eng., Mus., 1658A. (John Gay.)

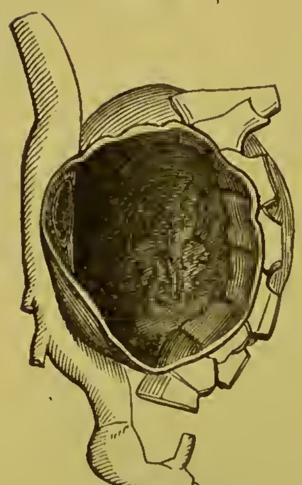
(2.) *The summit of the arch.*—A pulsating tumour appears behind the margin of the sternum (Fig. 123), and rising into the neck, commonly towards the right side, may simulate aneurism of the brachio-cephalic or carotid arteries. But the tumour has no defined lower boundary, being continued downwards into the thorax; and impulse, with dulness on percussion and a bellows or whirring sound, are felt and heard there. I shall have occasion to again notice the diagnostic significance of these cervical aneurismal loculi or sacculations of the thoracic arch, in connection with aneurisms of the innominate and carotid arteries springing from the arch, at the root of the neck.

Fig. 123.*



(3.) *The posterior wall of the descending aorta.*—A pulsating tumour appears posteriorly, to one side of the spine or under the scapula, commonly on the left side, and attains the size perhaps of a man's head, ere it bursts. (Fig. 124.)

Fig. 124.†



Apart from these three situations of aortic thoracic aneurism, other aspects of the aorta, as, for example, within the pericardium or the concavity of the aorta, are so placed with relation to adjoining parts, that aneurism proves fatal before any pulsating tumour becomes perceptible.

Pressure-effects vary with the particular situation of the aneurism, in its relation to surrounding parts, and according to its progressive size.

(1.) At the *root of the aorta*, and particularly in the intra-pericardial portion, an aneurism can scarcely attain any size before death occurs, by rupture into the pericardium.

(2.) At the *termination of the arch*, or the descending aorta, aneurism often attains considerable size without any particular pressure-effects. Dysphagia is, however,

* Royal College of Surgeons, Eng., Mus., 1664. In this case the aneurismal sac springs, by a narrow neck, from the posterior and upper part of the *transverse* portion of the aortic arch, just below the innominate artery. The sac assumed a flattened, transversely ovoid form, and was about four inches in its chief diameter; lying across the lower and front part of the neck, it pressed backwards upon the trachea, narrowing the canal, and ultimately bursting into the trachea with a small irregular opening in its anterior wall, immediately above the bifurcation. Owing to the symptoms of laryngeal obstruction, laryngotomy was performed in the crico-thyroid space. The arch of the aorta had undergone atheromatous degeneration on the cardiac side of the aneurism, but on the distal side the artery was healthy, and is not dilated. The heart is slightly enlarged.

† Ibid., Mus., 1675A. (Dr. J. Thurnam.)

the special symptom, the œsophagus lying immediately to the right of the tumour.

(3.) In the *concavity of the arch*, aneurism is beset with obstacles to its progress; notably, the bifurcation of the trachea, and either bronchus right or left, according to the inclining direction of the aneurismal enlargement. Dyspnœa is the urgent symptom, owing to the mechanical effect of pressure on the air tubes or pulmonary veins, or its influence on the left recurrent laryngeal nerve in its course round this portion of the aorta.

(4.) On the *posterior aspect of the arch*, aneurism soon occasions dyspnœa, with, subsequently, dysphagia; the concurrence of these two symptoms, therefore, has diagnostic significance.

(5.) At the *upper border, or convexity of the arch*, aneurism is attended with peculiar symptoms; cerebral disturbances, owing to interruption of the circulation through the carotid arteries.

(6.) On the *anterior aspect of the arch*, aneurism is less productive of pressure-effects than in any other part; œdema, only, slowly supervening by compression of the innominate veins.

Pain is a symptom common to all these aneurisms, as it is to aneurism in general. While, therefore, it cannot be reckoned a special symptom, its character is in some respects peculiar. The pain may be piercing and intermittent or neuralgic; arising from pressure on the nerves—spinal or sympathetic. Affecting principally the left side, it darts up the side of the head and face, radiating down the arm to the elbow, through the chest, or piercing to the scapula. Or the pain may be grinding, burning, and continuous; owing to excavation of the tissues and bones. This kind of pain affects chiefly the right side of the chest. In every case, pain is a very early symptom, as compared with symptoms more special and characteristic.

Diagnosis.—The special symptoms thus indicated by the anatomical relation of these aneurisms, are variously combined; and, indeed, this sort of diagrammatic view of the aneurismal aortic arch is often modified so as to present the most perplexing cases of diagnosis; either as to the existence of aneurism, or the particular portion of the arch which may be affected. The former question can only be determined by the presence of a tumour, pulsating as an aneurism; and, therefore, with reference only to either of the *three* first-named portions of the arch, the part also being thus indicated. Presuming the existence of aneurismal tumour, the second question—as to its situation—may perhaps be solved by due consideration of the special symptoms of functional disturbance referable to the several *aspects* of the aortic arch, which, although less favourably circumstanced for physical diagnosis, are more conducive to the manifestations of functional disturbance. Fortunately, this differential diagnosis as to the part affected, guides the special prognosis more than it modifies the treatment of these Aortic Aneurisms.

Treatment.—The same principles which guide the treatment of aneurism in general are here applicable, for the arrest, if possible, of thoracic aneurism in any part of the aortic arch; but any operative proceeding on the arch will obviously be out of the question. Tracheotomy may become justifiable, for the relief of urgent dyspnœa; but, as Professor Spence observes, only when dependent on laryngeal spasm from pressure of the aneurismal tumour on the recurrent

larnygeal nerve; when the urgency is due to pressure on the trachera, and necessarily below the seat of operation, such interference would be useless for affording even temporary relief. The proximity of the sac must be remembered, in using the knife or in entering the tube.

Aneurisms at the Root of the Neck.—*Diagnosis.*—These aneurisms are associated in virtue of their pathology, and their diagnosis. They are aneurisms of (1) the *innominate* artery, and (2) of the *commencement* of the *right common carotid* and *subclavian* arteries, respectively. Aneurism of the *thoracic* portion of the *left* common carotid or subclavian arteries is unknown.

In the diagnosis of the aneurisms referred to, at the root of the neck, on the *right* side, the special symptoms of aneurisms of the aortic arch must be duly considered; but the difficulty will be to determine which of the three arteries is the seat of aneurism.

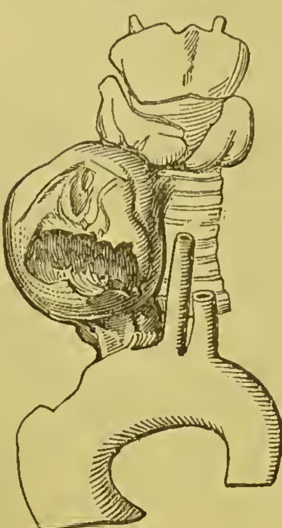
The observations of my colleague, Dr. Cockle—in his valuable contribution to our diagnostic knowledge of these aneurisms—are here to the purpose. "Whenever," says he, "a pulsating tumour which involves the root of the neck to any extent is first submitted to observation, and is unaccompanied by a sufficiently accurate previous history, there is generally a felt difficulty of diagnosis, whatever the actual *position* of the tumour may be. Such difficulty may occasionally arise from an inability to determine the real nature of the tumour, but most frequently (an aneurismal character being assumed) it consists in isolating the vessel engaged. The general rules laid down for guidance in this latter particular are based almost mainly upon the position of the tumour, and the relative state of the circulation in the corresponding arteries of the arm and neck." The rules, as laid down by Mr. Wardrop, are as follow:—Aneurism at the root of the carotid artery presents itself first in the small triangular space between the heads of the sterno-mastoid muscle. Aneurism of the subclavian presents on the outer or cervical side; and of the innominate, on the inner or tracheal side of that muscle. Then again, the pulse in the radial or brachial artery, or in the carotid or temporal, is less on the aneurismal side of the body. Diminished pulsation in the neck may indicate aneurism of the carotid trunk; in the arm, that of the subclavian; while diminished pulsation in both situations may indicate aneurism of the innominate artery.

But there are many exceptions to these general rules. Thus, the pulsating tumour of *aortic* aneurism may rise in the form of secondary sacculations ascending the neck, in the ordinary situation of innominate or carotid aneurism; and induce modifications in the circulation and sensibility of the right upper extremity. Or, instead of rising, an aortic aneurism may find its way amid the loose cellular texture of the thoracic mediastinum; but by compressing the innominate, carotid, or subclavian arteries, it will affect the pulse in the same situations as aneurism of these vessels.

Respecting *innominate* aneurism in particular, the differential diagnosis, observes Dr. Cockle, is attended with difficulties in tolerably direct proportion to the *part* of the trunk affected. "When the *origin* of the vessel is alone involved, it is"—in his experience—"invariably combined with aneurism, either true or false, of the ascending aorta. This form of innominate aneurism thus loses all individuality, and merges into the general pathology of aortic aneurism. It has abso-

lutely no clinical history of its own. If, as at times, though with extraordinary rarity, an aneurism should limit itself to the *mid-portion* of the trunk and anterior wall (Fig. 125), it may remain for a time, or even through its entire course, intra-thoracic, descending and moulding itself upon the aorta, evoking all the physical phenomena and symptoms of aneurism of the ascending and transverse aorta, or it may additionally, by one or more loculi, ascend the neck either on the tracheal or acromial side of the sterno-mastoid muscle. Should, therefore, a pulsating tumour, with or without cervical extensions, occupy the space corresponding to the second and third costal cartilages of the right side and upper portion of the sternum, and present the ordinary symptoms of aneurism; though we may be practically safe in locating the disease in the aorta, it is not from any inherent difference of signs or symptoms, but from the rarity of intra-thoracic innominate aneurism.

Fig. 125.*



"It is only when the *distal end* of the trunk becomes the seat of aneurism, that accuracy of diagnosis is attainable, though, in such case, the origins of the carotid and subclavian arteries often share the dilatation. Certain signs and symptoms are ascribed to innominate aneurism. Their value is high, in proportion as intra-thoracic disease can be eliminated; but extremely small, as the evidence for such disease increases. This is by far the most important point in diagnosis. The only possible source of error is the rare fact of an aortic sac arising from the convex wall of the arch, and mounting up the neck. Valuable aid is afforded by the knowledge of some antecedent local injury or violent and unusual effort; very many such cases being traumatic. These points determined; should severe pain of the right shoulder, clavicle, right side of the head, neck, and arm, with local venous congestion or œdema, precede the appearance of a pulsating tumour, which emerging from beneath the right sterno-clavicular articulation, and often displacing the head of the clavicle during its ascent, distends the space between the heads of the sterno-mastoid muscle, and fills the *episternal notch*—should there be marked weakening of pulsation in the right radial and carotid arteries, pressure upon one or other artery loosening the impulse on the tumour—should a murmur, loudest over the tumour and at the sterno-clavicular articulation, diminish downwards, yet ascend the arteries on the right side, if pervious, such murmur being absent upon the left side; then, an aneurism of the *terminal* portion of the innominate artery may, with tolerable certainty, be diagnosed."

* Royal College of Surgeons, Eng., Mus., 1680A. In this case, an *innominate* aneurism springs from the anterior and inner wall of the artery, in nearly its whole extent; attaining to a large size, and pressing forwards and inwards, it has slightly displaced the trachea. The sac contained some coagulum, but is filled with wool. The arch of the aorta just below is the seat of atheromatous and calcareous degeneration; and the first and second portions of the arch are slightly dilated, and slightly sacculated in parts. The carotid and subclavian arteries were healthy.

On the *left* side, at the root of the neck, aneurism of the aortic arch may simulate aneurism of the *intra-thoracic* portions of the common carotid or subclavian arteries, which are not themselves subject to aneurismal dilatation in this portion of their extent. I have met with only one intra-thoracic aneurism of this kind, as verified by dissection. (Fig. 126.)

FIG. 126.*

Pressure-effects.—Aneurisms of the innominate artery, and of the commencement of the carotid and subclavian arteries, produce the same pressure-effects—varying in degree—owing to their similar relations, for the most part, to surrounding structures. These effects have also a general resemblance to those produced by aneurisms of the aortic arch.

They are—dyspnœa, dysphagia, enlargement of the veins of the neck and right arm, with œdema and pain.

Dyspnœa arises from the mechanical effect of pressure on the trachea, and in the case of innominate aneurism, possibly on the right bronchus; or from pressure on the right recurrent laryngeal nerve. The latter occasion of dyspnœa is accompanied with some husky modification of the voice, or loss of voice, paroxysmal cough, and slight mucous expectoration. *Dysphagia* may be more or less complete. *Venous obstruction* is evinced by enlargement of the external jugular vein, the veins of the arm, and those below the clavicle in front of the right side of the chest. Œdema supervenes in the right eyelids, face, and head, and in the hand and arm. The *pain* has the usual heavy excavating character, in connection with the tumour, and acute intermittent character from varying pressure on the cervical and brachial plexus of nerves; this pain shooting up the right side of the neck, head, and face, spans the shoulder and front of the chest, and radiates down the arm to the hand. Some loss of muscular power in the right arm commonly supervenes.

The *diagnosis* from Tumours—not aneurismal—at the root of the neck, must be guided by the differential characters already described in connection with ANEURISM.

* Royal College of Surgeons Mus., 1669. The specimen, in this case, exhibits an aneurism situated immediately *beyond* the origin of the *left subclavian* artery; the upper wall of the aortic arch being there dilated into an aneurismal sac of an oval shape, flattened before and behind, and about three inches in its principal diameter. The sac was formed of all the coats of the artery, but the walls were very thin, and the mouth of the sac was as large as the canal of the aorta. No coagulum had been deposited. The position of the sac must have allowed the current of blood to have passed from the transverse portion of the arch, straight into the sac. Thus, the sac being constantly pressed towards the left, backwards, and somewhat downwards, its lower margin overlaid the lower part of the aortic arch, about an inch beyond the origin of the sac; and by this pressure, the aorta became bent at and near the part to which the ductus arteriosus is attached. The remaining portion of the aorta and the heart are of their normal size.

The Pulse in Aneurism of Aorta, and Vessels at Root of the Neck.—I am indebted to Dr. Mahomed for the following valuable description of the Pulse in connection with the diagnosis of Aortic and Cervical Aneurisms.—" If an aneurism occurs directly in the course of the blood stream passing to either radial, it will usually so far interfere with its flow as to impart to the pulse certain characters, recognizable in some measure by the finger, and still more accurately by the sphygmograph. These characters will be most marked if the aneurism be on some large vessel taking origin from the aorta, less so and perhaps altogether absent if the aneurism be of the aorta itself and not involving either of its branches. The characters imparted to the pulse-wave are produced by its passage through the more or less elastic sac, which acts in some measure as a buffer, does away with the suddenness of the impulse, and diminishes the volume of the wave. The chief characters of the aneurismal pulse recognizable by the finger are—(1) delay; (2) diminution in volume; (3) diminution in force; (4) persistency; (5) thrill. The latter, however, is only occasionally present, requiring certain peculiar conditions for its development.

" The characters of the sphymographic tracing in aneurism, together with the corresponding sensations imparted to the finger are as follows—(1) a sloping upstroke = delay; (2) diminished volume of wave; (3) impairment of percussion = diminution in force; (4) obliteration of secondary waves; (5) inequality of pressure employed on two sides; (6) occasionally vibratile waves = thrill.

" All these signs are well shown in Fig. 127*b*, obtained from a case of aneurism of the aorta, involving the origin and first part of left subclavian; the right pulse in this case (Fig. 127*a*) must not be considered a type of the normal pulse-wave.

" The presence of these signs more or less developed in one or both

Fig. 127.—Aneurism of Aorta, involving first part of Left Subclavian.

(*a.*) Right. Pr. 3 oz.

(*b.*) Left. Pr. 2 oz.

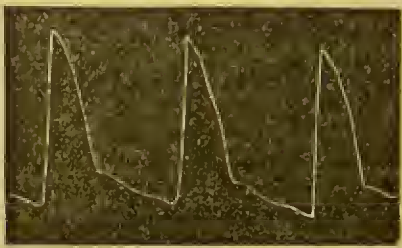
radial pulses may therefore afford important indications for the diagnosis and localization of an aneurism of the aorta. Thus their presence in the pulse at both wrists would indicate an aneurism of the ascending arch; but this rarely affects the pulse sufficiently to afford any indications other than such as might be produced by other conditions. If the right pulse be affected more than the left, the aneurism must involve the innominate; if the left more than the right, the aneurism is of the transverse arch beyond the innominate. An example

of the latter condition is seen in the tracings represented by Figs. 128*a*. and 128*b*. In this case the origin of the left subclavian was not involved. These tracings afford an illustration of another indication to be obtained by the sphygmograph, namely, the amount of general arterial disease and cardiac hypertrophy; Fig. 128*a* is a tracing characteristic of extensive disease of the heart and aorta, an observation which was confirmed by

FIG. 128.—Aneurism of Transverse Aorta, not involving Left Subclavian.

(*a.*) Right. Pr. 3 oz.

(*b.*) Left. Pr. 1 oz.



the post-mortem examination. The pulse tracings are also of value in these cases as a gauge of arterial tension, and the results of treatment, both on the general arterial tension and also on the local conditions; as consolidation takes place in the sac, the pulse previously affected loses its aneurismal characters.

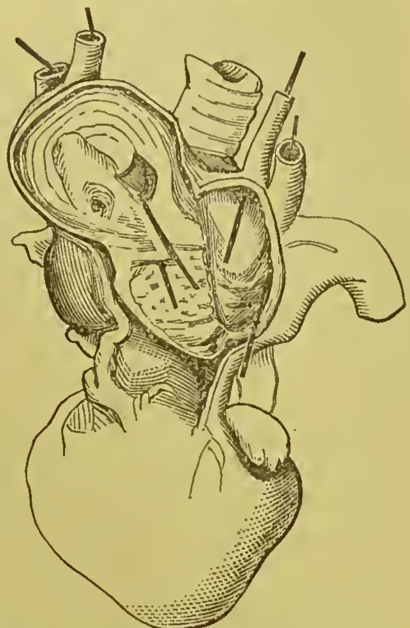
"Certain sources of fallacy exist, some of which it is impossible to guard against; thus aneurismal characters may be imparted to the pulse by pressure of an aneurismal sac upon an adjacent vessel; by pressure of a tumour other than aneurism upon a vessel; partial occlusion of a vessel by endarteritis or by an embolism; by vaso-motor paralysis, or irritation, relaxing or contracting the vessels on one side; by anatomical abnomalities; lastly, by inaccuracy of observation. Most of these errors, however, would be corrected by the general physical examination, which of course the sphygmograph is only intended to supplement, not to replace."

Causes.—Aneurisms at the foot of the neck are frequently traumatic; resulting from some violence, a blow, or strain in muscular exertion. Disease of the artery affected predisposes, however, to the occurrence of such aneurism.

Terminations.—These aneurisms are almost invariably fatal, although in a variable period. The probable duration will depend on the particular direction the aneurism takes with relation to adjacent parts; and death occurs usually by asphyxia, occasionally by rupture and repeated hæmorrhage. As a very rare event, the spontaneous cure of innominate aneurism may occur, as in the following case. (Fig. 129.) It will be observed that in the specimen here represented, there was a double aneurism—aortic and innominate; yet in both, the sacs

are completely filled with firm laminated coagulum. An instance of spontaneous cure, under circumstances thus apparently hopeless, should be considered in relation to the probability of cure by surgical interference.

Fig. 129.*



Treatment.—Constitutional treatment—hygenic and medicinal as for Aneurism in general—is said to have proved successful in several instances. But such resources having failed, the naturally fatal character of these aneurisms renders the alternative consideration of operative proceedings unavoidable. Hence, the primary importance of a corrected diagnosis of the peculiar vessel affected; either of the three vessels at the root of the neck being, possibly, the seat of aneurism. Tracheotomy may also be had recourse to, under similar circumstances, and with the same precaution in performing the operation, as with regard to aortic aneurisms. To avoid injuring the sac, the trachea might be entered, as Mr. Spence suggests, above the isthmus of the thyroid, which should be drawn down so as to expose the upper rings of the trachea.

(1.) *Innominate Aneurism.—Ligature*, on the *distal side*, may be resorted to; (*a*) of the subclavian artery alone; (*b*) of the carotid artery alone; (*c*) of both arteries. Neither of these modications of Brasdor's operation for Aneurism has been followed by any notably successful results.

Distal ligature of the *subclavian* alone has been practised in four cases, by Dupuytren, Wardrop, Laugier, and Broca. All were fatal, more immediately or remotely after operation. In the first case, death took place on the ninth day, from secondary hæmorrhage; in the second, two years after operation, from exhaustion; in the third, at the end of a month, from asphyxia; in the fourth, at the end of six months, from gangrene of the lung. The sac, in the first case, became smaller, the tumour diminishing, but its pulsations continued; in the second, the size and pulsation of the tumour diminished, but pulsation returned in the right carotid on the ninth day, thus apparently saving the life of the patient for two years; in the third, the aorta was dilated, but the right carotid obliterated by pressure of the tumour; in the fourth, the tumour became firmer, but not much diminished in size, and afterwards increased. In any case, ligature beyond the scaleni allows that portion of the current of blood through the aneurism to continue, which supplied the branches of the subclavian; namely, the superior intercostal, and internal mammary, the vertebral, and the thyroid axis. This direct transmission of blood in considerable quantity, not to mention that which passes off indirectly by the carotid artery, renders the probability of consolidation taking place in the sac all but hopeless.

* Roy. Coll. Surg. Mus., 1681a. (Dr. Dowse.)

Distal ligature of the *carotid* alone is not liable to this source of failure; no branch being given off from the parent trunk. The operation, as performed in nine cases of innominate aneurism, gave the following results. In eight, a fatal result ensued in periods varying from a few hours to a few days, or some months, even 20 months. Secondary hæmorrhage, asphyxia, and exhaustion were apparently the causes of death consequent on the operation, excepting in two of the cases; one dying—a few hours after operation—from insufficient supply of blood to the brain; the other—on the sixtieth day—from hemiplegia. The only successful case, by Evans, lived 39 years, and possibly longer. The sac, in these cases, underwent consolidation in various degrees, the tumour and its pulsation diminishing accordingly; but this reparative change seemed to have no proportionate relation to the period after ligature. Thus, in one dying on the seventh day, the tumour was nearly filled with firm laminated coagulum; whereas, in another, on the 115th day, no alteration in the tumour had taken place. Suppuration in, and rupture of, the sac occurred in one case; and also in the only case of recovery.

Distal ligature of *both* the carotid and subclavian arteries, for innominate aneurism, has been practised in four cases, by Fearn, Wickham, Malgaigne, and Rossi, with the following comparative results. In the first three, the vessels were ligatured successively; an interval of two years, or of two months, or six months, elapsing between the operations. In the fourth case, the vessels were ligatured simultaneously. All were fatal; the first dying in three months after the second operation, from pleurisy; the second, two and a half months after bursting of the sac. The third and fourth cases were fatal, in three weeks after the second operation, from erysipelas, and in six days after simultaneous ligature; but the latter of these two cases was remarkable for having survived that time, the supply of blood to the brain being wholly cut off by occlusion of the left carotid and right vertebral arteries, so that the cerebral circulation was carried on solely through the left vertebral artery. The sac in the first of these four cases, *i.e.*, after two years, was found filled with dense organized coagulum; leaving a channel of the size of the artery, for the passage of blood. In the second case the tumour diminished after ligature of the carotid, but increased after ligature of the subclavian had temporarily relieved recurring symptoms.

The following table of cases collected by Mr. T. Holmes includes the cases of operation for Aortic Aneurism:—

Distal Ligature in Aortic and Innominate Aneurisms.

Surgeon.	Artery affected.	Date.	Result.	Remarks.
		I. Double Consecutive Ligature.		
1. Fearn.	Innominate.	1836—1838.	Cured.	Preparation.
2. Wickham.	Ditto.	Sept.—Dec., 1839.	Died. Secondary hæmorrhage.	
3. Malgaigne.	Ditto.	Apr.—Oct., 1845.	Died. Erysipelas.	
4. Bickersteth.	Aorta and Innominate.	May—June, 1864.	Died. Suffocation.	

Surgeon.	Artery affected.	Date.	Result.	Remarks.
	II. Double Simultaneous Ligature.			
5. Hobart.	Aorta.	1839.	Died. Secondary hæmorrhage.	Subclavian, 1st part.
6. Rossi.	Innominate.	1843.	Died. Operation.	Subclavian, 1st part. (?)
7. Heath.	Aorta.	1865.	Recovered, and lived 4 years.	Preparation.
8. Maunder.	Ditto.	1867.	Died. Operation.	
9. Sands.	Ditto.	1868.	Recovered.	No benefit.
10. Durham.	—	—	—	
11. J. Lane.	Uncertain.	1871.	Recovered. Operation.	Ditto.
12. Holmes.	Aorta and Innominate.	1871.	Ditto.	Ditto.
	III. Carotid only.			
13. A. Key.	Innominate.	1830.	Died. Operation.	
14. Neumeister.	Ditto.	1830.	Died. Hemiplegia.	
15. Scott.	Ditto.	—	Died. Rupture.	
16. Dohlkoff.	Ditto.	1837.	Died. Paralysis.	
17. Hutton.	Ditto.	1846.	Died. Suppuration of sac.	
18. Wright.	Ditto.	1855.	Died. Cerebral abscess.	Aneurism consolidated.
19. Ordile.	Ditto.	1859. (?)	Died.	No particulars.
20. Broadbent.	Ditto.	1861.	Died. Secondary hæmorrhage.	No permanent benefit.
21. Hewson.	Ditto.	1867.	Died. Operation.	
22. Nussbaum.	Ditto.	—	Died. Rupture.	
23. Nussbaum.	Ditto.	—	Ditto.	
24. Evans.	Innominate and carotid.	1828.	Cured.	Lived thirty-nine years.
25. Morrison.	Ditto.	1832.	Cured.	Lived twenty months.
26. Vilardebo or Rompani.	Ditto.	1844.	Died. Secondary hæmorrhage.	
27. Pirogoff.	Ditto. (?)	—	Recovered.	Imperfect.
28. Mott.	Innominate and subclavian.	1829.	Recovered.	Lived seven months.
29. Fergusson.	Ditto.	1841.	Died. Pneumonia.	Preparation.
30. Porta.	Ditto.	1842.	Died. Erysipelas.	No aneurism.
31. O'Shaughnessy.	Aorta.	1843.	Died. Galvano-puncture.	
32. Campbell.	Aorta and innominate.	1845.	Died. Suffocation.	
33. Knowles.	Aorta.	1867.	Died. Apoplexy.	
34. Hutchinson, of Brooklyn.	Aorta and Innominate.	—	Died. Suffocation.	Double ligature attempted.
35. Rigen.	Aorta.	1829.	Recovered.	Left carotid tied.
36. Tillanus.	Ditto.	—	Recovered.	Ditto.
37. Montgomery.	Ditto.	—	Died. Suppuration of sac.	Ditto.
38. S. Lane.	Left carotid and Aorta.	1852.	Died. Rupture into lung.	Ditto.
39. Pirogoff.	Ditto. (?)	—	Recovered.	Ditto.
40. Pirogoff.	Aorta and innominate.	—	Died. Hemiplegia.	Ditto.
41. Heath.	Aorta.	1872.	Recovered. Much benefit.	Ditto.

Surgeon.	Artery affected.	Date.	Result.	Remarks.
IV. Subclavian only.				
42. Wardrop.	Innominate.	1827.	Recovered. Much benefit.	Lived two years.
43. Broca.	Ditto.	1862.	Recovered. Much benefit.	Lived seven months.

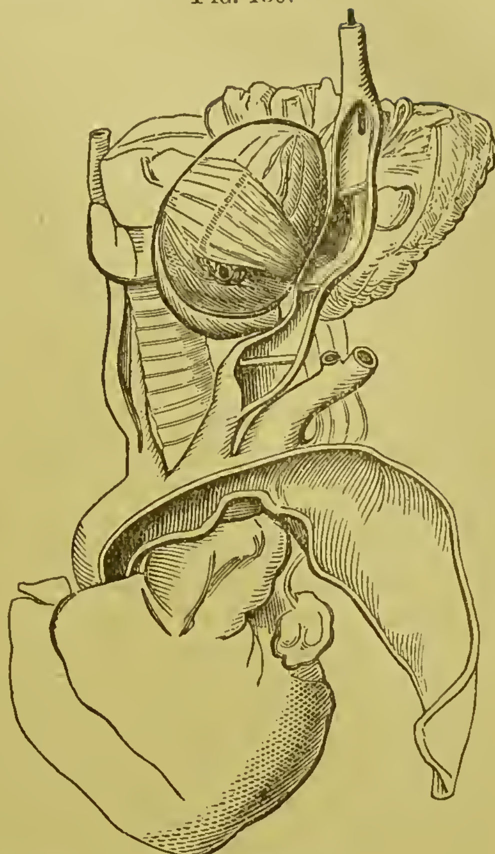
(2.) *Aneurisms of right carotid, and subclavian, arteries, at their origin—the root of the neck.—Ligature* of the *innominate* artery. This operation, in principle applicable to either of these aneurisms, is impracticable in some cases; and has been fatal in its result with regard to all the cases in which it has hitherto been practised, except in one instance. Eleven such cases have been collected by Mr. Erichsen, the operation having been commenced but not completed in four other cases. Ten of the cases were fatal. Of these, eight were cases of subclavian aneurism, the remaining two aneurism of both the subclavian and carotid arteries. In the former cases, death took place in periods varying from the fifth day to the sixty-seventh day; and, with scarcely an exception, from secondary hæmorrhage. In one case only, on the eighth day, death resulted from inflammation of the aneurismal sac, lung, and pleura. In the two cases of double aneurism, death occurred on the ninth and thirty-fourth days, but in both from accidental causes. The eleventh, and only successful case, was by Dr. Smith, of New Orleans, for a subclavian aneurism. In the four incompleted cases, the operation-difficulties were apparently the large size of the aneurism, or the diseased state of the innominate.

Carotid aneurism alone, at root of the neck.—*Distal* ligature of the artery. Six cases are recorded by Norris, in four of which the result was successful. This proportion is sufficient to justify a repetition of the operation, under favourable circumstances. In one case of traumatic aneurism of the carotid—at the root of the neck—arising from a stab in that situation, Mr. Syme performed the *old* operation for Aneurism; that of puncturing the sac, feeling with the finger in the sac for the aperture which controlled pulsation, then turning out the coagulum from the sac laid freely open, and securing the vessel by ligature above and below the aperture.

Subclavian aneurism alone, at the root of the neck—*i.e.*, situated either internal to, or between, the scaleni.—*Distal* ligature of the artery, in the *third* part of its course. This operation has been proposed, but I am not aware that it has ever been practised. The axillary artery below the clavicle, under the pectoral muscles, was ligatured by Dupuytren for subclavian aneurism; and this distal operation proved fatal, on the ninth day, from hæmorrhage. *Amputation* at the shoulder-joint, with, therefore, distal ligature of the artery, was suggested by Sir William Fergusson; the presumed advantage being, that the tumour might then be much more under the control of pressure, as the supply of blood below would no longer be requisite. This suggestion has not yet been tried; except in a case by Mr. Spence, of Edinburgh, and with a temporarily favourable result.

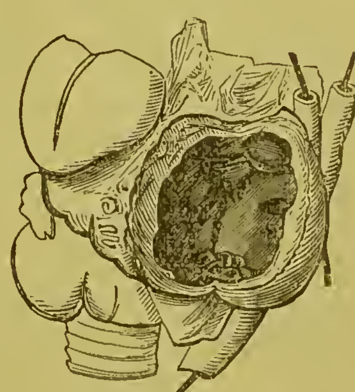
CAROTID ARTERY.

FIG. 130.*



ANEURISM. — *Symptoms.* — The usual symptoms of an aneurismal tumour are present, and well-marked, owing to the situation of carotid aneurism. (Fig. 130.) The pressure-effects are similar to those of carotid, subclavian, and innominate aneurisms, at the root of the neck, and those also of aneurisms of the aortic arch; so far as their anatomical relations are similar. Thus, the contiguity of the tumour to the trachea and œsophagus gives rise to increasing dyspnœa and dysphagia; compression of the recurrent laryngeal nerve occasions hoarseness or loss of voice; pressure on the cervical plexus is accompanied with some pain or loss of sensibility in the parts thence supplied; and there may be some giddiness or other cerebral disturbance, owing to interruption of the circulation through the aneurismal artery.

FIG. 131.†



Aneurism of the *external* carotid arises higher up in the neck, behind the angle of the jaw; and as the sac enlarges, the pressure-effects of the tumour varying according to its anatomical relations, the symptoms may be so far differential. (Fig. 131.)

The *diagnosis* of carotid aneurism must have regard to the various kinds of pulsating tumour which are liable to occur in connection with the carotid artery. Enlarged lymphatic glands, and tumours,

* Royal College of Surgeons, Eng., Mus., 1686. In the case here represented, the sac is of spheroidal shape, and has attained to a large size,—measuring between four and five inches in its chief diameter. The mouth of the sac, about one inch in diameter, oval, and smoothly bordered, is situated an inch below the bifurcation of the artery. All the adjacent parts are adherent to the sac, which compressed the larynx and trachea. But the sac is nearly filled with laminated coagulum, almost amounting to a natural cure. On the other hand, the carotid artery, both below and above the aneurism, is thickened and indurated, and the aorta also is the seat of degeneration. The other large arteries and the heart were apparently healthy.

† Roy. Coll. Surg., Mus., 1690. In the rare specimen from which the figure is taken, an aneurism springs from the external carotid artery close by its origin. The tumour was well-defined. The sac communicates with the vessel by a small

cysts, and abscess, situated on or communicating with the artery, may severally simulate aneurism. They are all pulsating swellings; but differing in the less expansive character of the pulsation, and the incompressibility, possibly, of the supposed aneurism. The history of the case will aid the diagnosis, as in that of abscess. The fluid, as well as the pulsating, character of any superimposed cyst or abscess, or when communicating with the artery, and virtually forming an aneurism, are the two conditions which require the utmost caution in diagnosis. Mr. Liston once inadvertently punctured a cervical abscess, which, having opened into the carotid artery, had thus become converted into aneurism. Pulsative tumours present even more perplexing difficulty. Pulsative enlargement of the thyroid body differs from a supposed aneurism, in its situation, and more particularly in the tumour moving up with the trachea in the act of deglutition. Any tumour, *not* communicating with the carotid artery, can be raised from the vessel, when the aneurismal symptoms will be found to cease; excepting the thrill of a pulsative tumour. Aneurismal varix of the internal jugular vein is an occasional question of diagnosis. In addition to the ordinary signs of varix, the notable diminution of the tumour during a deep inspiration will perhaps distinguish this condition.

Causes.—Carotid aneurism—unlike the aneurisms hitherto noticed, and in particular innominate aneurism—is rarely traumatic. Hence, probably, the fact that it occurs more frequently in the female than any other external aneurism. In 25 cases, 12 were in women. But the comparatively early age at which it may occur is remarkable; in one instance a girl of ten years, in another of eighteen. The right carotid is more commonly affected than the left, and the upper portion of the vessel than the lower; the bifurcation being the chosen seat of carotid aneurism.

Course and Terminations; and Prognosis.—An unfavourable career may generally be predicated, owing to the proximity of carotid aneurism to the central force of circulation—the heart—and also its important anatomical relations in the neck. Rupture, with recurring hæmorrhage, is one mode of termination; the tumour bursting externally, or into the pharynx or œsophagus. Asphyxia, by pressure on the larynx and recurrent nerve, is another termination. Starvation, by compression of the œsophagus, is yet a third issue, but not so imminent as either of the others. The particular part of the artery affected will materially modify the issue, and the duration of the case. It may be said generally, that the more distant the aneurism from the root of the neck, the less perilous are its pressure-effects, and the less imminent is any mode of fatal termination. Aneurism at the bifurcation of the carotid, below the angle of the jaw, may thus continue for years. At last, however, further want of space renders the contiguity of important parts increasingly perilous.

narrow, oval mouth, about one third of an inch in length, and having almost a vertical direction. A piece of whale-bone (represented in the figure) projects from either end of the artery; and the common carotid is similarly indicated. The walls of the sac were a quarter of an inch in thickness, formed of dense tissue, and not apparently by the coats of the vessel. Firm laminated coagulum has nearly obliterated the cavity. By pressure of the sac, the larynx is displaced, and the mucous membrane was very œdematous. The common and internal carotid arteries, as well as the continued trunk of the aneurismal external carotid, even to the borders of the mouth of the sac, are perfectly healthy. (Hunterian.)

Treatment.—Digital compression has been tried in five cases, and with successful results. Thus, by M. Rouge, of Lausanne, in the case of a man, aged sixty-eight, compression was effected laterally, the thumb being placed against the anterior edge of the sterno-mastoid, with the next three fingers under the posterior edge, so as to seize and compress the artery between them. In this way, pressure on the pneumogastric, which occurs when the carotid is compressed from the front against the sixth vertebra, was avoided; that mode of compression, if continued, being attended with great pain, which has proved to be the main cause of failure. The digital compression, as described, was continued for seventeen days, with periods of intermission, for an average of seven or eight hours each day, when a successful result was obtained.

Ligature on the *cardiac* side of the artery. This operation has certain important consequences relating to the brain, the lungs, and the aneurism.

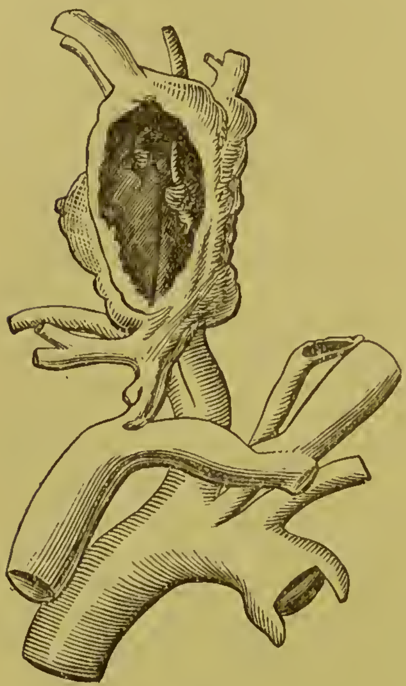
In 149 cases—tabulated by Dr. Norris—54, or more than one-third, died. Of these, secondary hæmorrhage was the cause of death in 15 cases; gangrenous softening of the brain, with various disturbances of the cerebral functions, in 12 cases. The latter consequences evidently depend on the seriously diminished supply of blood to the brain by ligature of the common carotid trunk, leaving only the vertebral artery to carry on the circulation in the same half of the brain. The free anastomosis of arteries at the base of the brain, constituting the circle of Willis, does not seem to sufficiently compensate for this deficiency. But the consequences will of course be doubly perilous, if both common carotids be ligatured. The *symptoms* of cerebral disturbance are giddiness, paralysis, blindness, deafness, and convulsive movements; followed by stupor, coma, and death. Inflammatory symptoms sometimes follow the operation. Softening of the brain ensues from mal-nutrition depending on defective circulation. The *frequency* of cerebral symptoms is attested by the statistics of Ehrmann. Of 187 cases, in which one carotid was tied, 42 were followed by some kind of cerebral disturbance. In 213 cases—including ligature of both carotids, and those of the innominate artery—cerebral symptoms ensued in 47, or about 22 per cent.

The following conclusions, according to Mr. Erichsen, seem to be established:—(1.) Ligature of one carotid artery is followed by cerebral disturbance in about one-fifth of the cases, more than one-half of which are fatal. (2.) Ligature of both carotids simultaneously, has always proved fatal; as in the two cases in which Mott and Langenbeck ligatured these vessels, an interval of only a few minutes elapsing between each operation. (3.) Ligature of both carotids, an interval of some days or weeks elapsing, is not more frequently followed by cerebral disturbance than when only one is tied. (4.) Obliteration of the vessels taking place gradually and successively, the patient may live; although one carotid and one of the vertebrals have been occluded by disease, and the other carotid ligatured, as in the case related by Rossi. (5.) Occlusion of both carotids and both vertebrals may yet allow life to continue for a considerable period, as in a case recorded by Dr. Davy; the cerebral circulation being maintained through the medium of the anastomoses of the intercostals and internal mammary arteries.

Congestion and inflammation of the lungs is another affection not unfrequently consequent on ligature of the carotid. The explanation of this condition is difficult. It may arise from deficient influence of the brain or medulla oblongata in its relation to the respiratory movements. Suppuration of the sac is apt to occur, as with other aneurisms, and even some weeks or months after the application of the ligature. Secondary hæmorrhage is another untoward event.

Recurrence of pulsation in the sac, soon after the ligature of the common trunk—on the cardiac side—is not an uncommon nor unfavourable event. It would appear to depend on the free communication of the arteries from the opposite side of the brain, returning blood through the branches of the internal carotid above the sac. A collateral circulation, however, becomes established through branches of the subclavian on the same side. Thus, in a case related by Porter, after ligature of the right carotid, the subclavian and vertebral arteries were enlarged to double their normal diameters; the latter artery supplying the function of the internal carotid, and the inferior thyroid communicating freely with the superior thyroid artery.

Fig. 132.*



Wounds, *and* Traumatic Aneurism, *of the Carotid Artery.—Ligature*, immediately above and below the seat of wound, is the appropriate operative procedure, as in wounds of other arteries.

Aneurismal Varix *of the Carotid Artery and Jugular Vein.*—Resulting from punctured wounds in the neck implicating both these vessels, in one instance, related by Mr. Macmurdo, aneurismal varix was consequent on disease. The only specimen with which I am acquainted exhibits a varix of the internal jugular vein, immediately above the junction with the innominate vein. This varix ascended and almost surrounded the common carotid artery, enlarging to the size and shape of a goose's egg. (Fig. 132.) The external carotid passes through the varix, being isolated to about half an inch in extent, and the internal carotid lies along the cavity behind.

Internal Carotid.

Extra-cranial Aneurism.—*Symptoms.*—The internal carotid, before its entrance into the carotid canal, may be the seat of aneurism. In situation, therefore, it nearly corresponds with aneurism of the common carotid at its bifurcation: but that of the internal carotid is situated under, or more immediately below, the angle of the jaw. The symptoms, also, are similar to those of common carotid aneurism, but there is

* St. Thom. Hosp. Mus., Y. 155.

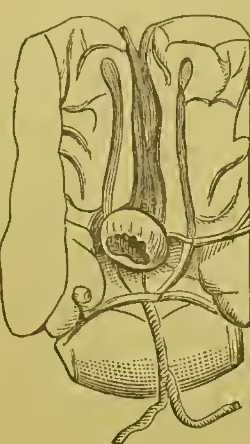
a greater tendency to extension of the tumour inwards towards the pharynx, the direction of least resistance.

Diagnosis.—Internal carotid aneurism may thus simulate abscess of the tonsil. The marked pulsation of the tumour in its pharyngeal aspect, which can be both seen and felt expanding with each beat into the mouth, will principally determine the diagnosis.

Treatment.—*Digital pressure* on the common carotid should be tried in the first instance. *Ligature* of that artery is the only available operative procedure, subsequently. Its results are uncertain.

Intra-cranial Aneurism.—*Symptoms.*—Within the cranium, aneurismal dilatation of the internal carotid may occur in either of the three parts of its course; (1) in the carotid canal; (2) in the cavernous sinus; (3) in relation to the brain. (Fig. 133.) Aneurisms of the other cerebral arteries are conveniently associated with that of the carotid in the latter situation.

Fig. 133.*



Of 62 cases noticed by Sir William Gull, the vertebral arteries and their branches were the seat of aneurism in 28, and the carotids and their branches in 34. The basilar artery was affected in 20 cases, and the middle cerebral in 15. In 8 cases, the internal carotid within the cavernous sinus was affected, and in 6 others the anterior cerebral artery.

(1.) In the *cavernous sinus* the symptoms are mainly those of aneurism, of pressure on the orbital nerves, and of disturbance of the cerebral circulation. Thus, arising, probably, from a blow or other injury, the person who is the subject of cavernous carotid aneurism, hears a sharp crack, followed by a sawing or rasping noise, which may also be heard by the stethoscope applied to the head or neck; but this sound ceases when pressure is made on the common carotid of the side affected. No tumour can be discovered externally. Pressure on the orbital nerves is announced, either by internal strabismus from paralysis of the sixth nerve, or by ptosis with external strabismus and dilated pupil from pressure on the third nerve, or by loss of sensation in the parts supplied by the supra-orbital nerve. The sense of vision usually remains unimpaired, or there may be double vision or other defect of sight. These affections of the orbital nerves exist singly or in combination. Cerebral disturbance is evinced by giddiness, headache, a sensation of fulness on stooping, and sleeplessness or disturbed sleep.

Diagnosis.—Similar symptoms may arise from any occasion of pressure on the artery in the sinus; as by coagula formed in the ophthalmic vein, the cavernous, circular, transverse, and superior petrosal sinuses. Otherwise the diagnosis of cavernous carotid aneurism can be made with tolerable certainty.

Intra-orbital aneurism is associated in point of situation and origin; the aneurism springing from the carotid artery, or, in some cases, from the ophthalmic branch. Anastomotic aneurism, or erectile tumour within the orbit, is an *independent* formation, and occurs more

* Univ. Coll. Mus. 287.

rarely; thus differing in its pathology from that of intra-orbital aneurism, which was formerly regarded as an erectile growth. Mr. Busk has shown that many of these true aneurisms are traumatic; and Mr. Nunneley maintains that all are ordinary spontaneous or traumatic aneurisms, except those which have spread into the orbit from a nævus of the face.

Diagnosis.—The following general distinctions are adduced in evidence of this view: Aneurism by anastomosis comes on gradually, mostly in early life, as the result of the growth of a congenital nævus; aneurism of the orbit very suddenly, often as the result of a blow, and almost always in advanced life; aneurism by anastomosis occurs in the subcutaneous tissues; aneurism of the orbit generally in the deepest part of the cavity; aneurism by anastomosis involves all the neighbouring vessels, arteries, and veins, in active disease; aneurism of the orbit is generally limited to a single part, or if the neighbouring vessels are dilated, they seem only enlarged from obstruction; ligature of the trunk of a vessel leading to an undoubted aneurism by anastomosis is an extremely unsuccessful operation, in aneurism of the orbit a very successful one; lastly, the cases dissected have turned out to be common aneurism. The diagnosis of *anastomotic* aneurism may perhaps be determined—as in Travers' and Dalrymple's cases—by the presence of soft, compressible, thrilling tumours in various parts of the eyelids; collections of veins apparently, transmitting pulsation from the subjacent aneurism.

(2.) *At the base, or in the substance of the brain*, aneurism of the cerebral branches of the internal carotid, or of the cerebrellar arteries, is liable to occur. The symptoms, if any, are very equivocal; pressure arising possibly from other causes than cerebral aneurism, and the diagnosis, therefore, is equally obscure. The sensation of a sawing or rasping noise in the head, varying with the circulation, and which probably has supervened shortly after some injury, may be suggestive of aneurism; a suspicion corroborated, perhaps, by careful auscultation of the head, leading to the detection of a bruit.

Diagnosis.—Symptoms referable to pressure may arise from any other tumour; and similar symptoms ensue from softening of the brain. Hence, general or partial paralysis, blindness, deafness, or other affections of the special senses, are symptoms of an equivocal character.

Causes.—A blow, a fall, or other traumatic mode of origin can be traced, in some cases; in others, the symptoms seem to arise spontaneously, without any previous ill-health. The cerebral arteries are said to be healthy, in most cases; but this is improbable. Age notably affects the liability to intra-cranial aneurism; the tendency increasing as life advances. Of 58 cases, in 12 only this condition occurred under twenty-five years of age, 5 of whom were under twenty; but of the remaining 46 cases, 13 occurred in persons under forty, 29 between forty and sixty, and 4 in persons above sixty. Sex seems to be predisposing, probably in connection with occupation. Of the 58 cases, 35 were males, 23 females.

Course and Terminations.—The pressure of an intra-cranial aneurism is followed by softening of the portion of brain, or cranial nerve, in contact; and, possibly, absorption of any opposing portion of bone. Symptoms of paralysis supervene. Death ensues by hemiplegia, or from apoplexy by rupture of the aneurismal sac; the latter mode of

death occurring more frequently in earlier life. According to Sir W. Gull's table, in 20 cases of persons under thirty-five years of age, 16, or 80 per cent., died from rupture of the sac ; while in 37 cases above thirty-five years, 14, or 38 per cent. only, terminated fatally in this way.

After death, much of the pathology of these aneurisms is made known by internal examination which could not be discovered during life, clinically, and which, therefore, cannot be applied in diagnosis. Generally, the aneurism is found to be a dilatation of the whole circumference of the artery, rather than a truly sacculated portion. Coagulation and the deposition of laminated fibrine may have proceeded to the almost spontaneous cure of the aneurism. Usually not larger in size than a pea or Barcelona nut, the aneurism is sometimes much larger, having attained the size of a walnut or hen's egg. Rupture may have occurred in quite the smaller-sized aneurism. A single aneurism only is found, rarely more. Thus, in one case, both carotids were dilated into bulbs occupying the hollow on each side of the sella Turcica, and which were filled with laminated coagulum. The preparation is in the Museum of the College of Surgeons.

Treatment.—*Digital pressure* on the common carotid artery may be sufficient to overcome the symptoms wherever intra-cranial aneurism is situated; and it has also proved successful in intra-orbital aneurism, under the care of Gioppi and Vanzetti. When this method of treatment has failed, *ligature* of the common carotid is the only known resource. It was signally successful in the case of a woman aged fifty-five, under Mr. Coe, of Bristol. After ligature of the left carotid, the cranial bruit ceased, a gentle continuous murmur followed, due apparently to the flow of blood through the tumour from the anastomosing branches; this subsided in about five hours, and all the symptoms ceased permanently. Great success has attended this operation in intra-orbital aneurism. Out of 20 cases, 14 were successful, 2 partially so, in 1 the pulsation continued, and 3 died. In other 13 cases, by English surgeons, 12 were cured. Digital pressure would seem to be at least advantageous in any case, as preparatory to ligature ; dilatation of the collateral arteries preventing the otherwise untoward symptoms which are apt to follow the latter procedure.

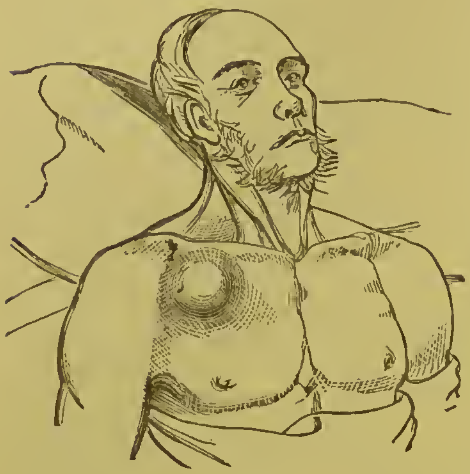
WOUNDS, *and* TRAUMATIC ANEURISM, *of the Internal or External Carotid and their branches.*—*Ligature above* and *below* the seat of wound may, perhaps, be impracticable, owing to the situation of the wounded vessel; or having failed to permanently arrest the hæmorrhage, the *common carotid* must be tied. The latter operation has certainly been successful in some cases. Traumatic aneurism having formed, ligature *in situ* will be more difficult; but even here the branches of either carotid, which are situated superficially, may be thus secured. The temporal artery, for example, has been wounded in cupping on the temple, and given rise to traumatic aneurism ; but as a branch of the external carotid and readily accessible, the tumour can be laid open, its contents turned out, and the vessel tied on either side of the aperture.

SUBCLAVIAN ARTERY.

ANEURISM.—*Symptoms.*—Aneurism of the subclavian artery presents a pulsating tumour situated immediately *above* the clavicle, and

commonly external to the margin of the sterno-mastoid muscle, the third part of the subclavian usually being affected. Its apparent size varies with the position of the shoulder, for the tumour disappears partly below the clavicle when the shoulder is raised. The annexed figure shows the *sub*clavicular tumour which was presented in a case that came under my care in the Royal Free Hospital (June, 1877). (Fig. 134.) Pressure on the brachial plexus is accompanied with pain, and numbness down the arm even to the fingers; and the phrenic nerve also sometimes becoming disturbed, there may be spasmodic action of the diaphragm—hiccup—as an occasional symptom. The external jugular and subclavian veins suffering compression, œdema, particularly of the hand and arm, will be conspicuous in most cases.

Fig. 134.



Diagnosis.—Other tumours may occasion similar symptoms; their *differential* characters, compared with those of aneurism, should therefore be remembered in considering the diagnosis. (See Tumours in the Neck.) As possibly simulating subclavian aneurism, I may mention an instance of aneurism springing from the *transversalis colli* artery, the preparation of which exists in the Museum of St. George's Hospital, vi. 113a.

Causes.—A traumatic origin can, generally, be traced—*e.g.*, a blow, fall on the shoulder, or violent muscular exertion of the arm. Hence, the more frequent occurrence of subclavian aneurism on the right side, and, perhaps, in connection with an occupation requiring constant use of the right arm; and, certainly, the far greater liability of males than females. In 32 cases, 2 only occurred in females, and both from injury.

Course and Terminations.—Slowly increasing in size, the tumour ultimately attains large dimensions; occupying the space between the clavicle and trapezius muscle. Never passing inwards, the trachea and œsophagus escape pressure; neither dyspnœa nor dysphagia supervene. But the tumour may extend somewhat downwards, and thus encroach on the apex of the lung. Extending yet further, upwards or downwards, the aneurism bursts externally, or internally with hæmorrhage into the pleura. Rarely, subclavian aneurism undergoes a spontaneous cure; the sac becoming consolidated with laminated fibrine.

Treatment.—*Ligature* of the *subclavian*, on the cardiac side, in the *first* part of its course. This operation has been practised for the cure of subclavian aneurism—in the *third* part of the vessel—*i.e.*, beyond the scaleni, and when situated between these muscles—the *second* part. In the eleven cases recorded, all were fatal, in periods varying from the fourth to the thirteenth, twenty-second, and thirty-sixth day; and uniformly from hæmorrhage, excepting in one case, where death occurred from pericarditis and pleurisy.

In my own case of aneurism, which was partly axillary, the patient, a man aged forty-two, first noticed a lump under the right

clavicle, about ten months before admission to the Royal Free Hospital. Three months previously, he was under treatment in the Newport Infirmary, where compression of the subclavian, in the third part of its course, had been tried on three occasions, without any marked effect. When first I saw the man, in consultation with my colleague, Dr. Cockle, a careful examination of the chest led to the conclusion that the heart was much diseased,—notably by dilatation of the right ventricle, and a loud regurgitant murmur at the base; this condition, being coupled with dilatation of the aorta, indicated the probability that the subclavian artery had undergone atheromatous and perhaps calcareous degeneration. There was also some occasional hæmoptysis. The pulsation of the tumour extended above as well as below the clavicle; and in the latter situation, the uniform surface and expansion of the swelling showed that the ribs had yielded. But the pulsation could be entirely stopped by compression of the artery above the clavicle, in the third part of the vessel, and just under the scalenus anticus muscle. Accordingly, having regard to the probably unsound state of the artery in that part, and the previous trial of compression, I resorted to pressure on the distal side of the aneurism, by means of a tourniquet on the axillary artery, the arm being bandaged from the fingers. This was continued for two or three hours, or as long as the patient could bear the pain, chloroform being unadvisable owing to the heart disease. But a repetition of this treatment, two or three times, having proved unsuccessful, I gave a final trial to compression on the cardiac side of the aneurism; digital pressure being applied, and continued by relays of assistants, on two occasions, for fourteen hours and eight hours; but without any perceptible result. I then resorted to galvano-puncture, using three insulated needles attached to a Foveaux's battery of eighteen cells. After one hour and a half, the tumour had considerably increased in size, but it felt more solid, and the pulsation less expansive. The influence of the current was therefore discontinued; and indeed the pain in the arm, bandaged from the fingers, had become almost unendurable; and the patient not being under chloroform, there seemed some risk that fatal syncope might occur. On leaving London (August 14th) for a fortnight, the case remained under the care of my colleague, Mr. William Rose; and as, in the course of a few days, the tumour rapidly enlarged and threatened to burst, he deemed it advisable, as a last resource, to ligature the subclavian. This was done in the third part of the artery. After four days, however, secondary hæmorrhage occurred, and the vessel was re-ligatured a quarter of an inch higher up. In the course of a week, hæmorrhage returned, and again the vessel was ligatured, yet higher up, beneath the scalenus. The pulsation in the aneurism, and in the radial artery at the wrist, was completely stopped by the first operation of ligature; but the patient rapidly sank, and died from exhaustion, with symptoms of pneumonia. Unfortunately, no post-mortem examination could be made, owing to the remarkably speedy decomposition which took place in a few hours; the body turning to a greenish-black colour, with general putrefactive emphysema. (From Report by Mr. Hamilton, Sen. Res. Medical Officer.)

Ligature of the *innominate* artery has also been fatal, almost beyond hope. The results of the eleven cases in which this operation was per-

formed, have already been noticed. Ten of the patients died. Nine were cases of subclavian aneurism; the remaining two, aneurism of both the subclavian and carotid arteries. The single successful case was a subclavian aneurism. (See Aneurisms at the root of the Neck.) In the following case by Mr. E. R. Bickersteth, of the Liverpool Royal Infirmary, the result was unsuccessful, death having taken place from hæmorrhage on the fourteenth day after operation; but the state of the artery, and of the aneurism, as found on dissection, showed a tendency to recovery, which is so far encouraging. (Fig. 135.) The innominate, from its origin to the point of ligature, being filled with a firm closely fitting plug of fibrine, was thus most satisfactorily occluded. Above the ligature, the vessel was empty; and in the aneurism, laminated clot-formation had completely closed up the sac. On the other hand, the distal portion of the subclavian, and first part of the axillary artery, were occluded. Two ligatures had been applied to the innominate, but very close together, leaving a linear interval, where the vessel had been compressed by a wire beneath and a metallic bar above. Both ligatures were found still *in situ*, and the hæmorrhage had proceeded from the distal side of the upper ligature, where the vessel had become partially severed. The wound was tolerably healthy. In connection with this case, it may be added that the heart was healthy, but the aorta exhibited atheromatous degeneration. All the other viscera were quite normal. The patient, a man aged forty, had been of strong muscular development, occupied as a dock porter; and by a strain the aneurism seems to have been produced, only three weeks before admission to the infirmary. (Med. Chir. Trans. vol. lvi.)

Fig. 135.

Aneurism of the subclavian, in the *first* part of the artery,—internal to the scaleni—might admit of compression, or of ligature, on the distal side of the tumour; but with what success remains to be shown.

Wounds, *and* Traumatic Aneurism, *of the Subclavian.*—Punctured wounds are occasionally met with, as a sword-thrust, or stab with a knife. Such a wound of the subclavian artery is usually fatal, before sufficient time has elapsed for traumatic aneurism to arise.

Aneurismal Varix *of the subclavian artery and vein* has been known to occur, in like manner.

Axillary Artery.

Aneurism.—*Symptoms.*—The situation of the pulsating tumour of Axillary Aneurism is characteristic. It rises immediately *below the* clavicle, under the great pectoral muscle, or under the anterior fold of the axilla, if the second, or third, portion of the artery be the seat of aneurism. Pressure on the brachial plexus occasions pain and numbness, extending down the arm and hand; œdema of the upper extremity also occurs from pressure on the axillary vein. But the situation of the tumour distinguishes it from subclavian aneurism, a very important distinction as to the portion of artery eligible for ligature.

Diagnosis.—Other tumours may be recognized by their *differential* characters. An abscess pulsating over the subjacent artery resembles aneurism in situation, but differs in the antecedent symptoms of inflammation. Pulsating tumour of the head of the humerus resembles aneurism in symptoms varying only in degree, but differs in situation, for it presents on the front of the shoulder.

Causes.—A blow or fall on the shoulder, violent movement, or other injury to the joint, is the mode of origin traceable in most cases. Forcible extension in the endeavour to reduce old-standing dislocations of the shoulder has furnished some instances of axillary aneurism, by rupture of the artery with the adhesions betwixt it and the bone. The traumatic origin of the aneurism renders its occurrence more frequent on the right, than the left, side; and more common in men than women. Of thirty-seven cases, three only happened in females.

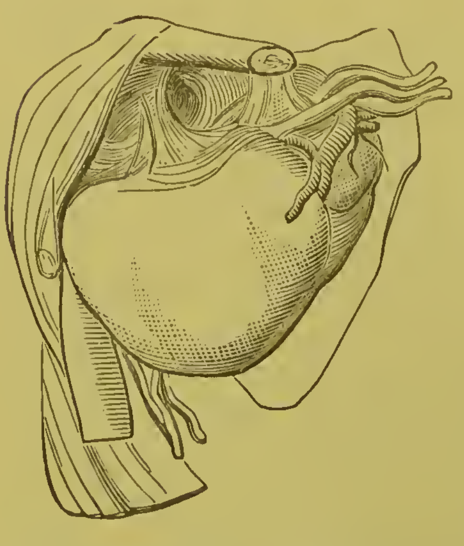
Course and Terminations.—Enlarging rapidly in the loose cellular texture of the axilla, the aneurism extends downwards and forwards; occupying the whole axillary space, and thus acquiring a larger size than aneurism in most other situations. Or it may take an upward direction, elevating the shoulder, or projecting above the clavicle into the angular space between it and the trapezius muscle. At length rupture takes place, externally, or internally into the pleura or lung. Spontaneous cure has never been known to occur.

Treatment.—*Compression* of the subclavian, in the third part of its course, may be either impracticable, owing to elevation of the shoulder or the projection upwards of the tumour, or it will be unendurable, owing to the unavoidable compression of the brachial pleux.

Ligature of the subclavian, in the *third* part of its course. This operation is the only resource, but its results have been most disastrous. In 48 cases of axillary aneurism, unconnected with any external wound, ligature of the third part of the subclavian terminated fatally in 25, while 23 were cured, a nearly equal proportion, or only 1 in 2. The causes of death consequent on the operation were, in some respects, peculiar; as shown by Mr. Erichsen's analysis of results. Inflammation within the chest in 10 cases; suppuration of the sac in 6; hæmorrhage in 3; suppurative phlebitis, 1; gangrene of hand and arm, 1; general gangrene, 1; not stated, 3. If we extend the statistics of this operation to all cases, including ligature for aneurism, the results are equally discouraging. Of 69 cases, tabulated by Norris, 33, against 36, died, about the same proportion as after the operation for aneurism. In 6 cases, more recently operated on in London, 2 only recovered. Porta's table of 74 cases is slightly more favourable than the returns of the same cases by Norris, *minus* the few additions. But the average

mortality of ligature of the subclavian in the third part, in all cases taken indiscriminately, would appear to be considerably above 40 per cent.! In the following remarkable case of axillary aneurism, the patient was a man forty-three years old. The aneurism was referable apparently to a fall on the ice, when the arm was extended. Six months elapsed before any perceptible swelling was noticed; and then, after increasing for three months, the man came under the care of Mr. Liston. At that time the aneurismal tumour was nearly twice the size to which it afterwards became reduced; the arm was enormously swollen, the upper part being indurated; the lower part, as well as the compressed and flattened side of the chest, soft and œdematous. In this state, the arm retained its natural temperature, but it was insensible and motionless, and the pulse of the radial artery could not be felt at the wrist. Mr. Liston ligatured the subclavian artery; and, for security, a second strong ligature was applied three-fourths of an inch nearer to the heart, close to the edge of the anterior scalenus muscle. At that part the artery was dilated, and its coats felt soft and thickened. After the operation, the case went on well for some days; but on the fifth day, there was increased pain in the tumour and down the arm, with much constitutional excitement. The patient was bled to eight ounces, and an anodyne was given, which afforded much relief. On the thirteenth day, oozing of blood began, and the following day the wound discharged dark, putrid blood. Compression succeeded in arresting this hæmorrhage, but the next day—the fifteenth after operation—the patient died from exhaustion. Then the wound was found full of coagulated blood; the upper ligature lay loose among the coagula, detached from the artery and enclosing a slough; the lower ligature was still attached, although the vessel was there extensively ulcerated. It appeared that the hæmorrhage had proceeded from this part. At the seat of the upper ligature the vessel was contracted, and contained a coagulum. The axillary artery passed over the inner part of the sac, adhered firmly to it, and had become obliterated three inches below the clavicle. Below the aneurism, the brachial artery had contracted to a small size, and coagulation had taken place in the vessel. All the anastomosing vessels were much enlarged to carry on a collateral circulation.

Fig. 136.*



The dissection in this case showed an enormous aneurism of the *axillary* artery, which occupied the whole axilla, elevating the shoulder, and pressing in the side of the chest; a portion of the sac extends downwards for two inches on the inner side of the biceps muscle. (Fig. 136.) The brachial plexus of nerves is stretched over and closely united to the sac, at its upper and anterior surface. The sac has a globular or ovoid form, and measures from six to eight inches in

* Roy. Coll. Surg. Mus., 1695; and Edin. Med. Journal, 1827, vol. xxvii. p. 4.

its several diameters; the prolongation downwards by the biceps is cylindriform, and about one inch and a half in diameter. The right subclavian artery is enlarged to twice its natural size from its origin to within an inch of the part where the two ligatures have been applied. Between the upper ligature and the dilated portion, the trunk of the artery is much contracted. The innominate, carotid, and the left subclavian arteries were little dilated; but the aorta was enlarged to about half more than its natural size.

WOUNDS, *and* TRAUMATIC ANEURISM, *of the Axillary Artery.—Ligature above* and *below* the puncture in, or division of, the vessel is the appropriate operation. It was performed by Mr. Syme in a case of ruptured axillary artery. Ligature of the artery *below the clavicle*, or of the *subclavian* above, must be had recourse to in cases where the previous operation is impracticable, owing to the great depth of the artery or other operative difficulty, or in the event of secondary hæmorrhage. Of 15 cases in which a ligature was applied below, or above, the clavicle, 9 were successful, and 6 died. The innominate was ligatured by Hutin, after operation on the subclavian had failed, from secondary hæmorrhage by the axillary wound, but with a fatal result in twelve hours.

BRACHIAL, RADIAL, AND ULNAR ARTERIES.

ANEURISM.—The axilla is the limit below which spontaneous aneurism rarely occurs in the upper extremity. But it has been met with in the brachial artery, and in this vessel at the bend of the elbow; in the radial and ulnar arteries, and as low down as the ball of the thumb. Aneurism in any such situation is readily recognized by the ordinary symptoms, and can scarcely be mistaken for anything else.

Causes.—Some injury is usually the immediate cause, but the vessel, probably, was previously diseased. This was the condition in an aneurism of the upper part of the ulnar artery, under the care of Mr. De Morgan, at the Middlesex Hospital. (Medical Times and Gazette, Nov. 22, 1862.) The traumatic origin of these aneurisms can generally be discovered in their history. An old ship carpenter, whilst at work, felt as if something had snapped in his arm. Mr. Liston ligatured the brachial artery. Aneurism of the radial artery at the ball of the thumb has followed an attempted reduction of dislocation.

Course and Termination.—These aneurisms rarely attain any considerable size, and may undergo a spontaneous cure. An aneurism of the radial artery, in a patient under Mr. De Morgan, recovered spontaneously.

Treatment.—*Compression* of the artery above the aneurism is available wherever the situation offers ready resistance, and it can be borne. As regards the brachial artery, the round form of the humerus, and the nerves of the brachial plexus, forbid compression. *Digital* pressure may be available; and in the aneurism referred to, of the ulnar artery, this mode of compression, maintained by the patient himself as long as he was able for several days, much reduced the size and pulsation of the tumour. On all these aneurisms, compression tells more effectually than in those of larger-sized arteries.

Ligature of the artery, above the aneurism. Thus, the brachial may be tied for aneurism at the bend of the elbow; the ulnar or radial for aneurism of these arteries; and the latter, if the aneurism be

situated at the ball of the thumb. Ligature of the brachial artery is usually very successful as regards the issue of the operation itself. In 68 cases tabulated by Porta, 10 died after the operation, but whether in consequence of it is uncertain.

WOUNDS, *and* TRAUMATIC ANEURISM, *of these Arteries.*—These lesions are as common as spontaneous aneurism of the same vessels is rare.

The *Treatment* is the same as for similar lesions of other arteries. *Double ligature* of the vessel at the seat of injury; or that failing, ligature of the artery *above.* Thus, in a case where the radial artery was almost divided by a scale off an iron bolt which had been thrust up the arm, I enlarged the track of the wound, turned out the coagula, and distinctly seeing the opening in the vessel, a ligature was applied above and below. To render this procedure bloodless, as in other cases, an Esmarch's elastic coil was applied over the brachial artery in the arm, the limb having been previously emptied of blood by the elastic bandage. After the operation, the profuse hæmorrhage at once ceased; the ligatures came away on the sixth day, without any return of the bleeding, and the wound healed. *Compression,* by means of a graduated compress, applied in the seat of wound, or above, if an aneurism have formed, might be tried in the first instance; but it will rarely prove sufficient to permanently arrest the hæmorrhage. This method of treatment is most successful in wounds of the *palmar arch,* there being a steady resistance to the compress by the metacarpal bones. But it may become necessary to tie the radial and ulnar arteries, and subsequently even to ligature the brachial.

ANEURISMAL VARIX, AND VARICOSE ANEURISM. — These conditions mostly occur at the bend of the elbow; the brachial artery and median basilic vein communicating, by puncture in unskilful venesection. Seldom met with, therefore, in these days of almost abandoned general blood-letting, the rules of treatment should still be remembered in the event of any such accident happening.

Compression, with an accurately applied compress and roller, over the puncture, will generally succeed in restraining aneurismal varix. But, after considerable enlargement of the vein—varix being established, or the formation of an intervening sac—varicose aneurism, it will be necessary to completely cut off the current of arterial blood, by *ligature* of the artery on either side of the aperture of communication.

Any other operative proceeding would be ligature of the arterial trunk *above;* an alternative rendered necessary only when the operation *in situ* is impracticable, but which is not so directly effectual.

ABDOMINAL AORTA; AND ILIAC ARTERIES, COMMON, INTERNAL, AND EXTERNAL.

ANEURISM.—*Symptoms.*—The symptoms of abdominal or pelvic aneurism are similar to those of aneurism in other situations. A tumour, the pulsations of which can be felt, heard, and perhaps seen externally; compressible, and subsiding if pressure can be made on the arterial trunk above. The pressure-effects are various, according to the relations of the tumour to adjacent viscera; pain also and œdema supervene as the nerves and venous trunks suffer compression. Thus, in parts supplied by the lumbar plexus, pain is experienced—*e.g.*, down the thigh and leg, if the anterior crural nerve be stretched over the

tumour; while œdema of the limb is occasioned by pressure on the vena cava, common or external iliac vein.

Diagnosis.—Other tumours may give rise to analogous symptoms.

Internal *abscess*, pulsating perhaps in connection with the aorta or iliac arteries, must be remembered as an occasional source of serious error in diagnosis. The distinction between abdominal or pelvic aneurism and *pulsatile tumours of bone* is most difficult.

The following characters seem to be generally distinctive, though seldom or never present collectively. In pulsatile tumours of bone: (1) the bruit is less marked or absent; (2) the pulsation is more sudden, less heaving and expansive, and equally forcible whether the tumour be large or small; while in aneurism, the force of pulsation is proportionate to the size of the tumour; (3) the bone connected with a pulsatile tumour is expanded, thus presenting a considerable osseous enlargement around the seat of disease—*e.g.*, the ilium on either side of a tumour developed in it; an aneurism simply eating an aperture, the margin of which may be felt if the tumour can be made to collapse. Osseous swelling determined the diagnosis of a pulsatile tumour of the ilium, in St. George's Hospital; the tumour projecting at the sacro-sciatic foramen and simulating aneurism of the gluteal artery. (Mus. II. 23). In a case recorded by Mr. Stanley, a plate of bone was found in the walls of the tumour. (4) Pulsatile tumour of bone is very commonly cancerous, and accompanied therefore with other evidence of this disease.

The *seat* of abdominal or pelvic aneurism—*i.e.*, the particular artery affected—will obviously be an important consideration in relation to treatment by any operative proceeding.

Treatment.—*Compression* of the artery above the aneurism is practicable only in very thin persons, and those who can bear prolonged compression of the aorta against the vertebral column. It can be effected, instrumentally, by means of a pad-compressor, or by digital pressure.

Ligature of the Abdominal Aorta.—This desperate operation has been practised in seven cases. By Sir A. Cooper, in 1817; and subsequently by James, of Exeter; by Murray, at the Cape of Good Hope; by Monteiro, at Rio Janeiro; by South; by Stokes, of Dublin, 1869; and by P. H. Watson, of Edinburgh, 1869. In Mr. Stokes's case, temporary deligation or modified acupressure was applied, by means of Mr. Porter's instrument. In the last case, by Dr. Watson, the common iliac artery had been tied, nine weeks previously, with an antiseptic catgut ligature. Secondary hæmorrhage ensued, the arteries being diseased, and the aorta was ligatured with a common silk ligature, about half an inch above the bifurcation. The external and internal iliacs on the affected side were also tied. All the cases were fatal, and as the result of the operation; the first case dying in 40 hours; the second, in the evening of the operation day; the third, in 23 hours; the fourth, on the tenth day; the fifth, in 43 hours; the sixth, in 12 hours; and the seventh, in 65 hours.

Such having been the unexceptional fatality of this operation, the particulars of the cases themselves are comparatively unimportant. Sir A. Cooper's case was an aneurism of the left common iliac artery and some portion of the vessel below. Mr. James's case was inguinal aneurism, for which he had previously performed the distal operation.

Monteiro's case was a large false aneurism in the lower and right side of the abdomen; the patient dying—on the tenth day—from secondary hæmorrhage.

Ligature of the Common Iliac.—This operation has not been uniformly fatal in its results. In 32 cases, collected by Dr. Stephen Smith, of New York, 25 died, 7 only recovered. But this list comprised ligature of the artery for all causes, including aneurism. Thus, (1) for arrest of hæmorrhage in wounds, or in surgical operations, 11 cases, 10 deaths; (2) for aneurism, 15 cases, 10 deaths; (3) for pulsating tumour mistaken for aneurism, 4 cases, 1 recovery; (4) to obviate hæmorrhage in an operation in one case, and in an aneurism by anastomosis in another, making 2 cases, both of which died. The causes of death were noted in 19 cases; gangrene in only 3, exhaustion 8, hæmorrhage 6, and peritonitis 2. Seven more cases may be added to Dr. Smith's table; 5 of which were fatal, and 2 successful—one by Bickersteth, of Liverpool, the other by Syme, in which he laid open the sac of an iliac aneurism, and tied the common, external, and internal iliac arteries opening into it.

Out of the total number of cases of ligature of the common iliac, 39, 29 have died, and 10 only recovered; in 9 the peritoneum was wounded, and of these 8 were fatal.

Aneurismal Varix of the Abdominal Aorta and Vena Cava.—Among the uncommon situations of Aneurismal Varix, that in which the abdominal aorta and vena cava are engaged is most rare. One such case is recorded by Mr. Syme, as having occurred spontaneously at the bifurcation of the aorta. I am enabled to verify this pathological condition by an *allied* specimen from the rich collection in St. Thomas's Hospital. (Fig. 137.) An aneurism the size of a hen's egg, and lined by a thin layer of fibrine, is situated at the point of bifurcation of the abdominal aorta. The left common iliac vein, which is greatly dilated, opens directly into it, and has no direct communication with the inferior cava. The superior mesenteric artery is completely obliterated for a considerable length, where it, with the mesentery, is converted into an inseparable) brawny mass. From a soldier, ætat. thirty-eight, whose left leg was crushed by a horse about three years before admission. He appeared to have quite recovered from the injury. Nine months before his death he complained of pain in his loins; a week subsequently, pain and enlargement of the leg, commencing in the foot, followed bathing. The veins of the leg and scrotum commenced dilating about four months before death, when they were very large. A tourniquet was applied to the abdominal aorta for seventeen hours, with an interval of half an hour; he did not complain of much discomfort, but sickness and hiccup ensued. Death occurred apparently from exhaustion. The

FIG. 137.*

* St. Thomas's Hosp. Mus., Y. 156.

mucous membrane throughout nearly the whole of the small and large intestines was of a yellow colour and dead; this condition being most marked over the valculæ conniventes, in places it involved all the coats. The intervening parts of the intestine were intensely congested.

Gluteal, Sciatic, and Pudic Arteries.

Aneurism.—*Symptoms.*—The three chief branches of the internal iliac artery are, each, liable to spontaneous aneurism; but the sciatic and pudic arteries are very rarely affected. An aneurism of the pudic artery is preserved in the Museum of the Royal College of Surgeons (specimen 1701). It is about the size of a walnut, and contains laminated fibrine.

The *gluteal* artery is more liable to aneurism. Its symptoms are not peculiar; but the situation of the pulsating tumour is the posterior part of the buttock, where the gluteal artery emerges from the sacro-sciatic notch of the ilium. (Royal Coll. Surg. Mus.)

As compared with pulsatile tumour of the ilium, the *diagnosis* must be guided by the distinctions already noticed. Encephaloid cancer may simulate aneurism, as happened in a case under the care of Mr. Guthrie, who ligatured the common iliac artery.

Treatment.—*Ligature of the Internal Iliac.*—This operation, first performed in 1812, by Dr. Stevens, has since been repeated in other cases. Of these five were unsuccessful, four successful, including one wherein the peritoneum was accidentally wounded.

Wounds, *and* Traumatic Aneurism, *of the Gluteal Artery.*—Diffused aneurism of enormous size may follow a wound of the gluteal artery. The famous case of punctured wound of this vessel, as related by John Bell, well illustrates the form of aneurism thence arising over the buttock.

Treatment.—*Double ligature* of the vessel at the seat of injury. This operation proved thoroughly successful in the above case. The incision over the tumour was two feet in length, and eight pounds of blood were turned out of the sac; but the man ultimately "walked stoutly," and regained good health. In a case operated on by Mr. Syme, the base of the tumour had attained the size of a man's head, it occupied the whole hip, and rose into a blunt cone. The result was successful.

Common Femoral Artery.

Aneurism.—*Symptoms.*—The pulsating tumour of aneurism of the common femoral trunk arises in the groin, but it may pass partly upwards into the abdomen. Situated, otherwise, external to the pelvis (Fig. 138), the characters of aneurism are more readily perceptible than when the tumour is internal. Its pressure-effects are evinced by pain in the groin and down the thigh, the genito-crural and branches of the anterior crural nerves being affected; and œdema of the leg supervenes, owing to compression of the femoral and saphena veins.

The *diagnosis* must still have regard to the possibility of abscess or a cyst pulsating in connection with the artery; and that of a pulsating tumour of the ilium. Inguinal aneurism has been punctured by mistake for abscess; and cases of pulsating tumour simulating aneurism in the groin have occurred to both Mr. Stanley and Mr. Syme. But the pulse below an aneurism, as compared with the pulse in the

other limb, is reduced; and this distinction will aid in determining the diagnosis of a pulsating tumour.

Causes.—A blow, strain, or other injury has seemed to be the immediate cause of inguinal aneurism, in some cases.

Fig. 138.*

Course and Terminations.—Restrained by the fascia lata, in the thigh, and by the pelvic fascia above, the tumour enlarges slowly, but may ultimately attain a large size. It is said never to become diffused, the fascia effectually circumscribing the aneurism; but it acquires a lobulated character under the unequal resistance thus offered to the increasing tumour.

A spontaneous cure has been known to take place in a few instances.

Treatment.—Compression on the External Iliac.—This proceeding is practicable in persons not too stout, and has proved sufficiently successful to encourage a repetition. *Digital* compression was effectual in a case under Mr. Fox, of the Pennsylvania Hospital; the want of assistants, however, prevented him from thus completing the cure. Another case—in St. George's Hospital—was entirely cured by mixed digital and mechanical compression. *Distal* compression succeeded in a case of fusiform ilio-inguinal aneurism under my care; the patient being a man seventy-five years of age, with a sonorous aortic cardiac murmur. Carte's tourniquet was used, just below the groin, and continued for a period of some weeks; when the aneurism had become consolidated so far as to transmit only the normal current of blood through the common femoral artery.

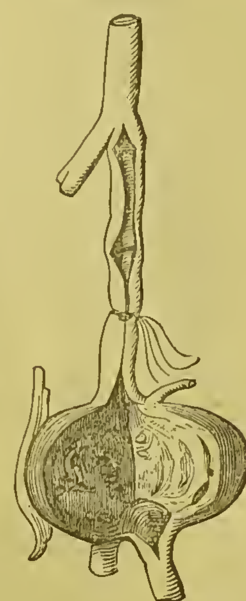
Ligature of the External Iliac.—First performed by Abernethy, in 1796, this operation has since been practised in at least 100 cases, according to Norris's table. Of these, 73 were cured, and 27 died. In 92 cases, the aneurism was seated entirely in the groin; and of these, 70 were cured, and 22 died. The causes of death were partly referable to the operation; namely, gangrene of the limb, in 8; secondary hæmorrhage, in 4; sloughing of the sac, in 3; from tetanus, 3; and from more general causes, 4. Inguinal with popliteal aneurism of the same side co-existed in a few of these cases. This complication does not appear to lessen the efficacy of the operation. Of 4 such cases, ligature of the external iliac was successful in 3; the other one dying of gangrene, but the popliteal aneurism, in that case, was about to burst at the time of operation. In 118 cases of ligature for all purposes, including aneurism, 33 died; and in 30 of these, 13 died of gangrene, 6 of secondary hæmorrhage, 3 of sloughing of the sac, 2 of tetanus, 2 of prostration, 2 of peritonitis, 1 of diffuse inflammation,

* St. Thom. Hosp. Mus., Y. 96. Aneurism of the common femoral artery, right limb. Situated immediately below Poupart's ligament, the sac has a globular form, and was about the size of a large walnut. On the posterior aspect—not shown—the sac is laid open; the walls consist of an expansion of all the coats of the artery, with cartilaginous thickening in parts.

and 1 of delirium tremens. Of the remaining 2 out of 33, one death was unconnected with the operation, and in the other case the cause is not specified.

Pulsation returned in the sac in six of the aneurismal cases; several weeks after the operation in some cases, and followed by death in only one case. In two of the three successful cases after ligature for double aneurism on the same side, pulsation returned in the inguinal aneurism; but it ceased, after a while, in both.

Fig. 139.*



In the following case, ligature of the external iliac (Fig. 139) had a successful result with regard to the aneurism. The sac is quite full of clot, mostly colourless; and the artery also is plugged with coagulum, between the sac and the ligature, and at a part two and three inches above it. Below the sac, the artery is free from clot. Death occurred fifteen days after the operation, from "secondary deposits" in the lung.

Ligature of the common iliac must be had recourse to, if the aneurism extends beneath Poupart's ligament into the pelvis, or partially involves the external iliac.

Wounds, *and* Traumatic Aneurism, *of the Common Femoral Artery.*—*Double ligature* of the vessel at the seat of the injury is the rule of treatment established by Guthrie's observations in this, as in all similar cases. The artery being wounded so near to Poupart's ligament, hæmorrhage will of course be more perilous, owing to the great difficulty of compressing the vessel above, in applying the ligatures.

Secondary hæmorrhage also and gangrene are both imminent subsequently.

Amputation is the only resource in either of these events; ligature of the external iliac has invariably failed to prevent the recurrence of secondary hæmorrhage.

Aneurismal Varix, *and* Varicose Aneurism, *in the Groin.*—*Double ligature*; the tumour having been laid open, and the aperture of communication between the vessels sought. This operative proceeding is recommended by Guthrie, as for varix and varicose aneurism occurring in other situations. But the unavoidably perilous hæmorrhage, in seeking the aperture of communication between the femoral artery and vein, will always be a most serious consideration; for it will be found impossible to safely control the hæmorrhage during the operation, by compressing the artery above.

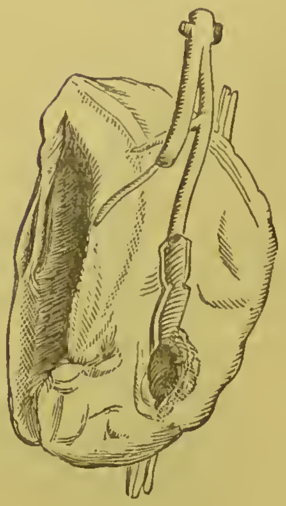
Ligature of the external iliac—the alternative operation—has, on the other hand, failed entirely. In the four cases recorded, a fatal termination was referable to the operation; two dying of secondary hæmorrhage, and two of gangrene.

* St. George's Hosp. Mus. vi. 119.

Femoral Artery—Deep, and Superficial.

Aneurism.—*Symptoms.*—The *deep* femoral artery is very rarely the seat of aneurism. Two cases only can I find recorded; one by Mr. Bryant, in a patient of Mr. Cock's, at Guy's Hospital; the other under the care of Dr. Garrod, at University College Hospital. (Fig. 140.) In the former case, the aneurism was at the origin of the deep femoral; in the latter, lower down. The symptoms of aneurism thus situated, are necessarily somewhat obscured by the depth of the artery.

Fig. 140.*



The *superficial* femoral artery is rarely the seat of aneurism, but far more frequently than the deep femoral; and as affecting this artery, it is known as Femoral Aneurism. The symptoms are more perceptible—the tumour being more superficial; particularly if situated in Scarpa's triangle, the usual situation. Aneurism springing from this—the first portion of the femoral—is unsupported by muscles immediately behind it; thus forming more readily and rapidly, it presents a pulsating tumour, having the characters of aneurism well defined. They are obscured only by the fascia lata, superficial fascia, and integument. Aneurism arising from the second portion of the femoral—within Hunter's canal—is not only more deeply placed, but is supported by the adductor muscles, and resisted by the aponeurotic covering of the canal, and the superimposed sartorius muscle; as well as by the fascia lata, superficial fascia, and integument. The pulsating tumour, therefore, has characters less distinctly aneurismal.

The *Pressure-effects* of femoral aneurism—whichever portion of the artery be affected—will consist in the pain and œdema produced by compression of branches of the anterior crural nerve, and of the femoral and saphena veins. In Hunter's canal, the internal saphenous nerve—a branch of the anterior crural—and the femoral vein, are here peculiarly subject to pressure.

Treatment.—*Compression* of the *common femoral*, in the groin, should always be tried in the first instance. It has been known to succeed, even when the aneurism has burst and become diffused. If the tumour continue to increase, the establishment of a tolerably free collateral circulation will prepare the way for the next resource.

Ligature of the *common femoral*, in the groin.—The results of this operation are decidedly unfavourable. Secondary hæmorrhage is apt to follow, owing apparently to the contiguity of arterial branches—the circumflex ilii above and the deep femoral below the ligature; the free communication of which vessels is, however, requisite for the collateral circulation. Gangrene, on the other hand, is apt to ensue, in the event of the arterial trunk becoming occluded below the ligature, thus shutting off the supply of blood through the deep femoral, as well as through the superficial femoral leading to the aneurism. Of 12 cases, in which the common femoral had been ligatured, secondary hæmor-

* Univ. Coll. Mus., 290.

rhage occurred in 9, 3 of which were fatal, and 6 were saved only by ligature of the external iliac; the remaining 3 were successful.

Ligature of the superficial femoral will be practicable only in cases where the portion of this artery, between the sac below and origin of the deep femoral above, is of sufficient length for the application of a ligature. But this operation avoids both the sources of danger consequent on ligature of the common femoral. Ligature of the superficial femoral, in the part referred to, may be eligible for aneurism situated in the apex of Scarpa's triangle, and would certainly be appropriate for aneurism in Hunter's canal.

Wounds, *and* Traumatic Aneurism, *of the Femoral Artery.*—These lesions are liable to happen by puncture with some sharp instrument, or by rupture, or penetration of the artery, with or by fracture of the femur.

Cases of this description are not very uncommon. The following instance well illustrates the symptoms. The femoral artery of a young man was wounded with a penknife. On the following day—observes John Bell—aneurism began to form, but as yet the wounded artery was not so far removed from the fascia and surface of the thigh but that pure blood found its way out through the integuments, and he lost at a few strokes of the heart no less than three pounds of blood; on the third day, however, the coagula were so firm, the wounded artery was so deeply buried under the coagulating blood, and the external wound so steadily compressed, that it healed. Then, the aneurism assumed its proper form of a great pulsating tumour, but circumscribed, and limited to the upper and fore part of the thigh; very little swelling of the limb had supervened after the lapse of three weeks. In another case, a man was sitting in a careless way cutting a rag or flaw from the root of his nail, and the scissors, which were very sharp-pointed, dropping betwixt his thighs, he suddenly clapped his knees together to catch them, and struck the points into his thigh, wounding the femoral. The blood instantly spurted out, was soon stopped, and the external wound healed in a few days; then aneurism began to form.

The *Treatment* presents nothing peculiar;—*double ligature* of the artery at the seat of the wound; or, if secondary hæmorrhage occurs, *ligature* of the *trunk* above must be had recourse to.

Aneurismal Varix, *and* Varicose Aneurism, *in the Thigh.*—In the event of either such possible mode of communication between the femoral artery and vein, the treatment would be analogous to that for similar conditions of the common femoral artery and vein in the groin.

Popliteal Artery.

Aneurism.—*Symptoms.*—Popliteal Aneurism is declared by a pulsating tumour, which forms in the popliteal space, or ham. (Fig. 141.) At first small, circumscribed and of roundish shape, soft and compressible, it subsides also by pressure on the femoral trunk. This latter symptom, as Sir A. Cooper observed, may be more readily perceived by looking at the tumour from the level of the limb. The pulsation, like that of other external aneurisms, can be seen and felt, as well as heard, transmitting a *bruit.* But the character of the pulsation is modified by the aspect of the artery, whence the aneurism

springs. When it arises from the posterior aspect of the vessel, towards the skin, popliteal aneurism has the usual heaving and expansive character; arising from the anterior aspect towards the joint, the aneurism raises the vessel more to the surface, and the pulsation is thrilling, the beat of the vessel also, in its course, being, perhaps, felt distinctly separate. Such was the case in a typical instance which I found in the Museum of the Royal College of Surgeons—a Hunterian specimen marked 1703, and which is here represented. (Fig. 142.)

Fig. 141.*

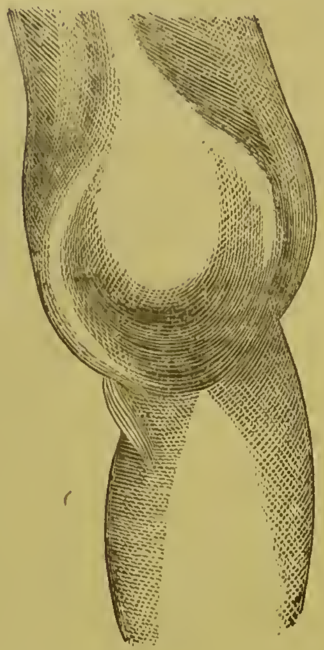
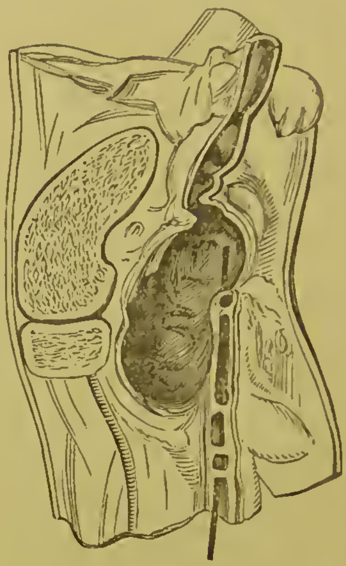


Fig. 142.†



The *pressure-effects* of popliteal aneurism are, as with other aneurisms, pain and œdema, preceded by some stiffness of the knee-joint, and a semi-flexed position of the limb. Lameness is, indeed, often one of the earliest symptoms of the disease.

The *diagnosis* is usually unequivocal. But the pain and inability to use the joint may be mistaken for rheumatism; and other tumours in connection with the popliteal artery have a pulsatile character transmitted to them—*e.g.*, chronic abscess, a cyst, or solid tumour, in the popliteal space. The pulsation, however, is less expansive, the tumour incompressible, and it does not subside on pressure of the femoral trunk. These differences disappear in the event of aneurism having

* Case of large popliteal aneurism. (Author, Royal Free Hospital.)

† In this aneurism of the popliteal artery, the figure exhibits a vertical section of the sac, and of the femur and tibia in the knee-joint; showing that the sac springs from the anterior side of the artery, and lies between the vessel and the back of the joint. The sac, now empty, was filled with coagulated blood. The course of the artery above and below is indicated by a piece of whale-bone within the vessel; and thus the entrance and exit portions of artery are seen not to be opposite each other. Above, the artery is very much contracted, especially at the aneurismal orifice; below, the artery would seem not to have transmitted blood into the posterior tibial, as a fine-glue injection did not pass out. The inner coat of the artery was the seat of fatty degeneration; limited, however, to the portion of the vessel just above the aneurism, and extending into the interior of the sac, where the inner coat is similarly diseased. Below the sac, the artery appeared to be nearly in a healthy state. (Hunterian.)

undergone consolidation; thus so far resembling a solid tumour. But any independent tumour can, perhaps, be lifted off, and isolated from the artery, when its pulsatile and apparently aneurismal character ceases. The history of the case will aid in determining the diagnosis; as, for example, with regard to chronic abscess.

Causes.—Some strain in flexion or extension of the joint seems to be the usual mode of origin. Hence, popliteal aneurism occurs more frequently in persons accustomed to the athletic exercises of running or jumping, or who ride hard on horseback. Sailors, according to Dr. Crisp, would appear to be more subject to the disease than any other class. Men, generally, are far more liable than females. Of 155 cases, in Norris's table, five only were females. The *period of life* most liable is between thirty and fifty. As compared with other aneurisms, popliteal aneurism is far less frequently associated with a diseased state of the arterial system, and with aneurism, consequently, in other parts of the body. Both popliteal arteries are affected with equal frequency, and occasionally at the same time. On the other hand, compared with other arteries, the popliteal is prone to aneurism. Thus, of 551 cases of aneurism collected by Dr. Crisp, 137 were popliteal, and only 66 femoral.

Course and Terminations.—Enlarging usually with tolerable rapidity, the aspect of the artery from which the aneurism arises, regulates the rate of its progress. On the anterior aspect of the vessel, aneurism is resisted by the joint or the lower end of the femur, and increases slowly. Constant pressure on these parts is followed by synovitis or caries, and the tumour ultimately bursts into the joint. On the posterior aspect of the vessel, aneurism being supported by the hamstring muscles on either side, but restrained only by the integuments, it enlarges rapidly. Becoming diffused, it may burst upwards into the cellular texture of the thigh; or backwards, under the integuments of the popliteal space; or downwards, under the fascia overlying the posterior tibial vessels and nerve.

Rupture of the sac terminates the previous aneurismal symptoms.

Treatment.—*Genuflexion* was originally practised by Dr. Mannoir, of Geneva, and, in this country, by Mr. Ernest Hart. It should be tried, in the first instance. If bending the knee back on the thigh stops the pulsation in the tumour, this treatment may be continued. The limb having been bandaged from the toes nearly to the knee, the roller should be turned round the thigh, the leg being flexed at an acute angle; the thigh is then bent upon the pelvis, and the knee rested against a pillow. In the course of from two days to a week, cure may be completed. This method of treatment proved successful in thirty-five cases, two of which had resisted compression of the femoral artery. But from my own experience, I would strongly urge the propriety of restricting flexion to cases in which the aneurism is of small size, otherwise the sac tends to burst; and where the leg is not tensely swollen, or gangrene may speedily supervene. In Mr. Hart's case, the cure had made considerable advance after the first day of flexion, and was complete on the fourth day; on the seventh the patient was moving about. Other successful cases have since been recorded.

Flexion is in fact a mode of compression; this being the next resource when that has failed, or is ineligible owing to the large size of the aneurism.

Compression of the Femoral Artery.—Instrumental or digital compression may be readily effected; care being taken that the pressure be directed rather outwards against the femur, as the vessel winds to the inner side of the bone in its course down the thigh to become popliteal. But this kind of treatment may be unbearable. Or, the tumour still enlarging, compression will no longer prove sufficient to induce consolidation of the aneurism, and still less so, if the sac has burst, and diffused aneurism being established, gangrene is imminent.

Ligature of the Superficial Femoral.—This operative proceeding becomes necessary under the circumstances adverse to compression, or its continuance. Ligature of the superficial femoral has been attended with more successful results than that of any other main artery. The vessel is usually secured at the apex of Scarpa's triangle, just as it passes under the sartorius muscle.

In 110 cases collected by Dr. Crisp, 12 only had a fatal issue; by secondary hæmorrhage, 4; by gangrene, 3; and the remainder dying of phlebitis, tetanus, etc. Of 33 cases operated on in London, Hutchinson shows that 10 were fatal; 5 dying from gangrene. This would seem to be the chief cause of death after ligature of the femoral for all purposes, including popliteal aneurism. Thus, of 204 such operations in Norris's tables, 50 died. Of these, the cause of death is omitted in 4; but of the remaining 46, 23 or one-half died from gangrene, and 8 only from hæmorrhage; 5 of phlebitis; 1 from sloughing of the sac, and the residue from accidental causes common to all operations, as tetanus, pyæmia, etc. Return of pulsation in the sac sometimes occurs, but it rarely is of much consequence. Compression of the artery above will, mostly, control any such unfavourable tendency.

Secondary hæmorrhage should be met by ligature of the artery above—*i.e.*, the common femoral, or the external iliac; pressure with a graduated compress fixed over the bleeding aperture will be insufficient, and double ligature of the vessel *in situ* impracticable; and, in extreme cases, amputation is the only resource.

Amputation of the Limb.—This operation must be resorted to in the event of *gangrene*, consequent on the aneurism, or its having become diffused, or after ligature of the superficial femoral. Persistent *secondary hæmorrhage* will also render amputation unavoidable. Limited gangrene may allow the preservation of the limb.

Amputation has proved tolerably successful in its results, more so than ligature of the femoral, taking either operation in all cases indiscriminately. Of 50 cases of ligature collected by Mr. Hutchinson from the practice of the metropolitan hospitals, 16 died, or say one-third; whereas, amputation of the thigh—in all the cases collected by Mr. Bryant from Guy's Hospital, and by Mr. Holmes from St. George's Hospital—shows a mortality considerably below one-third.

Double Popliteal Aneurism.—*Compression* of the femoral seems specially appropriate in double popliteal aneurism, as thus to avoid that disturbance of the balance of the circulation which is certain to ensue when one vessel is ligatured, and which may act injuriously upon the opposite aneurism. In a case where an interval of some months elapsed between the two aneurisms, I succeeded in curing the first by instrumental compression, and the second, in the opposite

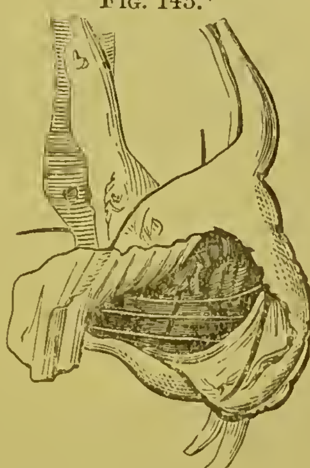
ham, became consolidated, but I learnt that subsequently this aneurism returned.

Ligature of the artery has occasionally been practised with advantage on both sides; either simultaneously, or, with more safety, consecutively.

WOUNDS, *and* TRAUMATIC ANEURISM, *of the Popliteal Artery.*—Should either of these lesions occur, they would present nothing peculiar as to symptoms of treatment.

Rupture of the artery, subcutaneously, has been met with. In one case, *double ligature* of the vessel was performed by Mr. Poland, with an unsuccessful result, gangrene having supervened on the third day, followed by amputation and death. But no difficulty was experienced in the operation. The only two other cases wherein double ligature of the popliteal has been attempted, failed in the operation. Ligature of the *femoral* has been tried in two cases, both of which terminated fatally by gangrene. In one case, accompanied with rupture of the popliteal vein, which occurred in my own practice, gangrene ensued, for which *amputation* was performed above the knee, with, however, a fatal result (page 375). The following case is probably *unique*, but it will prepare the Surgeon for that which may happen again. (Fig. 143.) A popliteal artery, vein, and nerve, showing an *arterio-venous aneurism*, and in which the sac consists of an expansion of the *nerve-fibres*, some of them traversing the cavity of the sac, and the whole then reunite in the nerve. In its minute structure, the sac is composed of an external fibrous investment, continuous with the nerve-sheath or neurilemma, and of an internal delicate lining membrane. Two vessels open into the sac, a small vein and a small artery. The patient, a woman aged thirty-two, had received a blow in the left ham, from a rotating pump-handle. Fourteen days afterwards, a swelling formed the size of a nut, and in six months attained to its present size, that of a small orange. It did not pulsate, but was the seat of stabbing pain, which extended down to the sole of the foot. It was twice punctured, and gave vent to venous blood. Afterwards an incision was made, and the tumour was found to contain venous blood, and blood had extravasated into the surrounding cellular recesses of the knee. Amputation was then resorted to, and the patient recovered. (See also Med. Chir. Trans., vol. xlix.) (C. H. Moore.)

FIG. 143.*



TIBIAL ARTERIES—ANTERIOR AND POSTERIOR.

ANEURISM.—*Symptoms.*—Very rarely, spontaneous aneurism occurs below the knee, in connection with either of the tibial arteries. A small aneurism of the posterior tibial is preserved as a preparation in the Museum of St. George's Hospital. The symptoms will probably be obscure, owing to the small size of any such aneurism, and its depth

* Middlesex Hosp. Mus., S. v. 76.

from the surface; especially as connected with the posterior tibial, throughout the greater portion of the course of that vessel.

The *Treatment* must be conducted on the same principles as for aneurism in other situations; *compression* above the tumour, when practicable; or, that having failed, *ligature* of the *femoral* should be duly considered, with reference to the probability of curing the aneurism and also the consequent perils of this operation.

WOUNDS *and* TRAUMATIC ANEURISM.—*Double ligature* of the vessel, at the seat of wound, or the resulting aneurism, is unquestionably, as in all similar cases, the appropriate rule of treatment. But this operative procedure may be rendered impracticable by the depth of the vessel, especially in a muscular limb, and increased by the infiltration of blood. Under these circumstances, other procedures have, occasionally, been resorted to; and, in the event of secondary hæmorrhage, they must be taken into consideration.

Ligature of the popliteal or femoral artery has thus proved successful in arresting hæmorrhage. Wound of the posterior tibial, with secondary hæmorrhage, warranted ligature of the popliteal artery, in a case under the care of Samuel Cooper; and diffused traumatic aneurism of the same vessel seemed to justify ligature of the femoral, in a case under Dupuytren.

Amputation should always be the last resource.

ANEURISMAL VARIX, *and* VARICOSE ANEURISM.—The latter condition has occurred in the posterior tibial artery and one of the venæ comites, just above the internal annular ligament at the ankle-joint. The two vessels communicated through a small circumscribed aneurism intervening between them. No history, I believe, could be ascertained; this varicose aneurism having been discovered by Mr. Cadge in the dissecting room of University College, when he was Demonstrator of Anatomy in that Institution; and I well remember he showed me the specimen, which is, I believe, unique.

CHAPTER XXVII.

LIGATURE OF ARTERIES.

OPERATIONS for the Ligature of Arteries are more conveniently and instructively described apart from the various Aneurisms to which these Operations pertain.

By viewing the Arterial System thus Surgically as a whole, the similarity of anatomical relations in contiguous portions of the same artery will save much unnecessary repetition, which would otherwise be unavoidable, in describing the operations for their ligature.

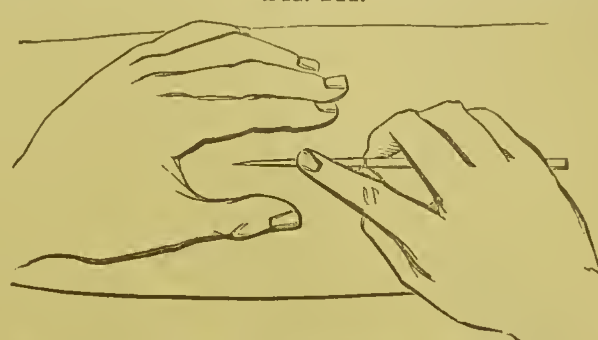
Certain *general directions* are applicable to the ligature of all arteries; and they relate either to the operation as performed on an artery in its continuity, or at the seat of a wound involving an artery.

LIGATURE OF AN ARTERY IN ITS CONTINUITY.—This operation consists in dividing the textures down to the artery, and then applying a ligature around the vessel. A muscle or tendon, or perhaps a bone, is observed as the recognized guide for the *incision*. Thus, the inner

border of the biceps muscle guides to the brachial artery, the tendon of the supinator longus leads to the radial, and the upper margin of the clavicle, in its outer third, is the line of incision leading to the subclavian in the third part of its course. In the absence of any such anatomical "directing line," a line can, mostly, be drawn corresponding to the course of the artery. For example, midway between the anterior superior spinous process of the ilium and symphysis of the pubes, a line commencing and terminating on the inner side of the patella nearly indicates the course of the femoral artery.

The *incision* may be made in the line thus indicated naturally or artificially, or obliquely across that line; the latter direction guiding to the artery which it bisects in some point of its course, and leading more clearly to the parts adjacent on either side of the vessel. The *length* of incision should be proportionate to the depth of the artery which has to be reached, thence varying from one to three inches or more; but generally the skin alone should be first divided, the integument being gently stretched, without displacement, by the fingers of the left hand. (Fig. 144.) Then, the subjacent fascia, its superficial and deep layers, and muscle in some cases, must be carefully divided, in succession; any known veins or arterial branches being avoided, if possible, or hæmorrhage from them commanded by pressure, torsion, or ligature. Adjoining the artery, a nerve may be found, lying by the side of the vessel, but outside its sheath—*e.g.*, the ulnar nerve in collateral relation to the ulnar artery; or several nerves may surround the vessel, as the brachial plexus in relation to the brachial artery. Any such superficial vessels, the border of a muscle or tendon, and nerves, are conveniently drawn to one side and protected, and the wound made more open, by curved metallic spatulæ or retractors; wherewith retraction can be gently maintained by an assistant, as the textures are successively divided, and also during the passage of the ligature-needle around the artery.

FIG. 144.



The *sheath* of the artery having been reached — as denoted by its dense cellular character, and the pulsation of the enclosed vessel, immediately beneath the finger —that structure should be slightly raised with the forceps, into a small cone off the artery, and the knife being laid flat under the pinch of the forceps, a small

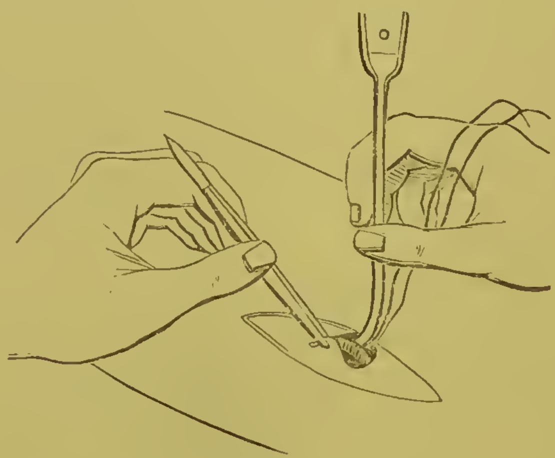
FIG. 145.

aperture is cut in this portion of the sheath. (Fig. 145.) The artery thus exposed through the aperture will be recognized by its whitish-yellow or fawn colour. Enclosed within the sheath, by the side of the artery, lies the small companion vein, or two such veins, *venæ comites*, one on either side, in relation to a second-sized artery. It, or they, have a dark-blue colour, contrasting with the colour of the artery; but an enclosed vein may be only partially visible through the small aperture in the sheath. A nerve also is sometimes enclosed, as the pneumogastric within the sheath of the carotid, but it has less immediate relation to the artery; while external to the sheath, the collateral nerve or nerves already referred to will be seen, in immediate relation to the artery.

Fig. 146.

An aneurism-needle, armed with a waxed silk ligature (Fig. 146), is introduced through the aperture in the sheath, between the vein and artery, and turned round the latter (Fig. 147); their cellular connection having, previously, been gently separated, if necessary, by scratching with the point of the needle. The *ligature* is drawn out from the eye of the needle, and the needle itself withdrawn; leaving one end of the thread on either side of the artery. Special care should be observed not to slide the ligature up and down the artery, nor to lift up the vessel much from its bed; whereby, in either

Fig. 147.



way, the nutrient *vasa vasorum* would be cut or torn off, endangering sloughing of the vessel and secondary hæmorrhage. The ligature should be tied transversely round the artery (Fig. 148), as an oblique direction of the noose would be liable to loosen; the ends of the thread must be drawn moderately tight, so as to divide the two inner coats of the vessel, and then the thread tied again, forming a reef-knot. (Fig. 149.)

It must be observed in these proceedings, that the *vein* be not wounded or transfixed, nor any adjacent *nerve* included in the ligature

with the artery. But care should also be taken not to ligature any extraneous structure *instead* of the vessel; as a nerve, or portion of the sheath. The finger placed on the *distal* side of the artery will at once

FIG. 148.

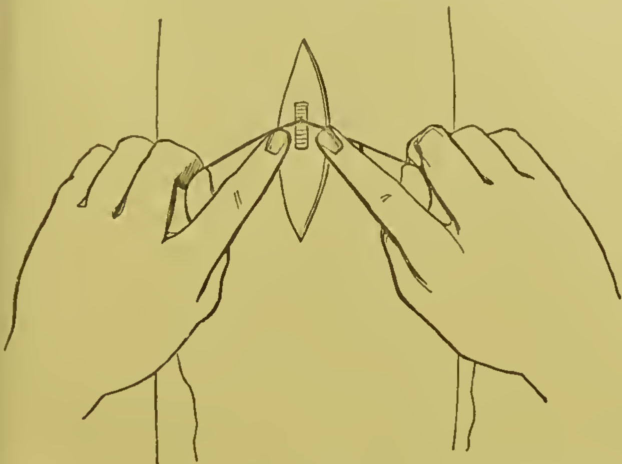
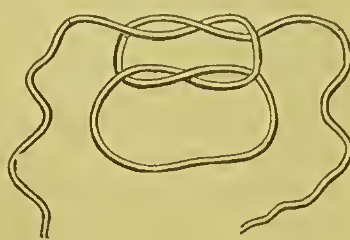


FIG. 149.



discover whether pulsation is stopped, and the vessel secured. One end of the ligature is then to be snipped off close to the knot on the vessel, and the other end left hanging out of the wound, guarded by a small strip of adhesive plaster; and, lastly, a piece of wet lint is placed over the incision, which may be partly closed by a few points of suture.

LIGATURE OF AN ARTERY AT THE SEAT OF A WOUND, INVOLVING THE VESSEL.—The wound is here used as the incision, leading down to the artery. It may require to be enlarged, as in the case of a punctured or other narrow wound; and much difficulty may be experienced in finding the vessel, owing to the infiltration of surrounding textures with blood. The artery may be found *punctured*, or completely *divided*. In either case, the rule of treatment for securing it and arresting hæmorrhage is the same. A ligature must be applied on either side of the aperture, or to either cut extremity; this *double ligature* being necessary to stop the hæmorrhage from the distal, as well as the cardiac, end of the artery—which would otherwise continue to bleed by the anastomotic supply of blood from above the upper ligature. In this procedure, a tourniquet is placed on the limb above, to control the main trunk.

Puncture, or division, of an arterial branch *close* to the *trunk* whence it springs, is equivalent to an aperture in that vessel of equal size to the branch or the puncture in it. The same treatment therefore will be requisite; ligature of the trunk above and below the branch.

Ligature of an artery, on the *surface* of a wound—*e.g.*, a stump after amputation—has been described in connection with INCISED WOUND.

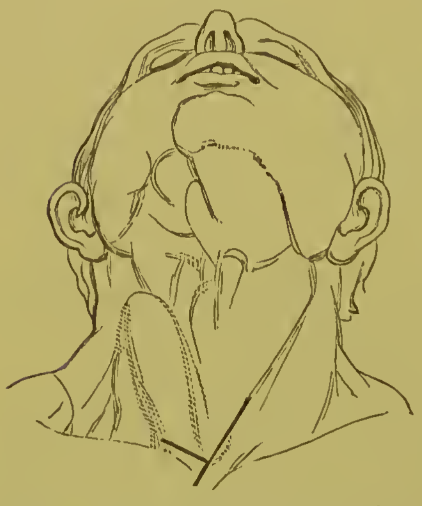
The Ligature of Arteries will now be described severally, and in consecutive order from the commencement of the Arterial System to the Extremities; and with each such Operation I think it desirable to associate a preparatory summary of the Surgical Anatomy of the Artery.

LIGATURE OF THE INNOMINATE OR BRACHIO-CEPHALIC ARTERY.—*Surgical Anatomy.*—This artery *arises* from the commencement of the transverse portion of the arch of the aorta, and ascends *obliquely* to

the right, as high as the *sterno-clavicular* articulation; where it divides into right subclavian and right carotid arteries. Its *length* is, usually, an inch and a half to two inches. Situated within the thorax, behind the first piece of the sternum, the vessel is immediately *overlaid*—from below upwards—by the left innominate vein, crossing its root, the sterno-hyoid and sterno-thyroid muscles; and above it passes between and behind the cellular interval of the sternal and clavicular portions of the sterno-mastoid muscle. *Posterior* to the artery is the trachea, on which it lies obliquely; on its *left* side is the left carotid artery, but as the innominate ascends to the right, a considerable interval separates the two vessels, in which appears the trachea, with some remains of the thymus gland; on the *right* side is the right innominate vein. Nearly parallel with the artery, and along the outer side of the vein, is the phrenic nerve and the pleura. The pneumogastric nerve, entering the thorax, between the subclavian artery and innominate vein, gives off its recurrent branch around that artery, and then dips backwards by the side of the trachea, to lie in the interval between that tube and the œsophagus. This nerve, therefore, has no immediate relation to the innominate artery, otherwise than just as the nerve enters the thorax behind the vein and to the right of the artery, here lying on the right side of the trachea.

Operation.—The innominate may be reached from *above* the sternum. The patient being placed in the recumbent position, and the head thrown well back, exposing the root of the neck, an incision is commenced in the epi-sternal notch near the right sterno-clavicular articulation, and carried upwards to the left, for about three inches, near the inner side of the left sterno-mastoid muscle. (Fig. 150.) A second incision, if necessary, may be made from over the sternal origin of the right sterno-mastoid muscle, meeting the lower end of the first incision at nearly a right angle. The skin and superficial fascia are thus divided, and if a flap of integument has been formed by the second incision, it is turned up; the deep fascia is cautiously divided, and the finger passed down the trachea to the artery; or, if a flap be made, the sternal origin of the right sterno-mastoid muscle and a few fibres of the sterno-thyroid and hyoid muscles may also be divided, and the root of the carotid thus exposed is followed down to the innominate. A round curved aneurism-needle, armed with a ligature, is then passed around the vessel, and the ligature secured, with all the skill the Surgeon can command. A needle having a point which can be detached, when felt under the vessel, may help to facilitate this critical part of the operation.

Fig. 150.



The innominate has been reached *anteriorly*, by removing a piece of the sternum and sternal end of the clavicle. This was done by Cooper, of San Francisco, in a case where the upper end of the innominate artery itself was diseased, and the aneurism affected the

root of the subclavian and carotid arteries. But it is only for the cure of aneurisms in that situation that ligature of the innominate would ever be contemplated; and disease of any portion of this vessel —the seat of operation—would be a positively forbidden condition. In the case referred to, and in all instances of the less formidable operation above the sternum, the result has been fatal.

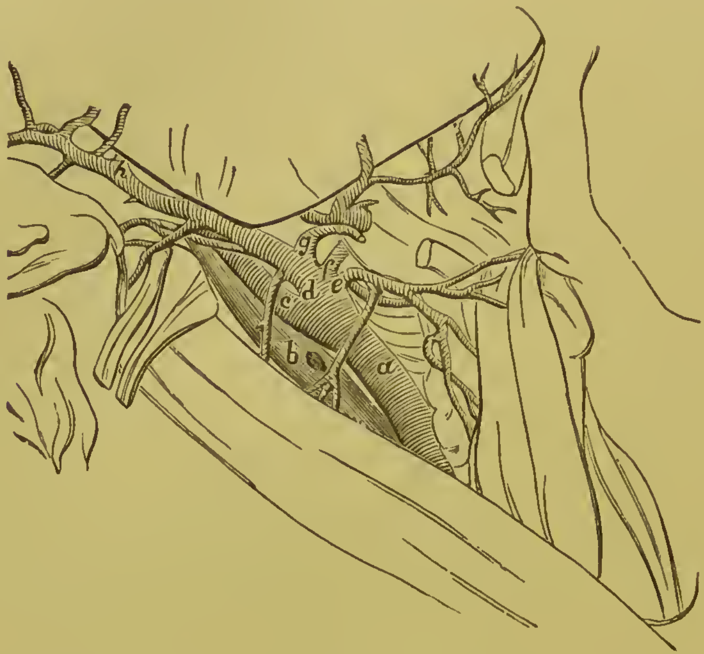
LIGATURE OF THE INTERNAL MAMMARY ARTERY.—Goyraud, by whom this operation was first performed, gives the following directions for reaching the internal mammary artery:—"An incision, two inches in length, is to be made near the edge of the sternum, obliquely from above downward and from without inward, forming with the axis of the body an angle of forty-five degrees. The middle part of this incision should be three or four lines distant from the margin of the sternum, and in the centre of the sternal end of the intercostal space. (See Fig. 156.) Dividing successively the skin and sub-cellular adipose tissue, and then the great pectoral muscle, the intercostal space is exposed. An incision is then made in the same direction and over the entire width of the space of the aponeurotic layer, which continues the external intercostal muscle and the superficial fibres of the internal intercostal. With a grooved director, the fibres of the latter muscle are to be separated and torn through, and the artery and its two venæ comites are laid bare at three lines from the edge of the sternum, which separates these fibres from the pleura. Then, nothing is easier than to isolate the artery and to slide beneath it the curved end of an aneurism-needle, for passing the thread." But, with regard to this procedure, it should be observed that, simple as it may be on the dead subject and when the artery is injected, the circumstances under which the operation may be requisite, or deemed advisable, render it one of the most difficult in the practice of Surgery. Thus, in gunshot wound of the sternum, attended with profuse hæmorrhage, apparently from the internal mammary artery, forming a large bloody swelling, with an accumulation of clots in the mediastinum,—then, indeed, the depth and relations of the vessel are altogether changed, although the peril to life may justify immediate interference. The case is similar to a false aneurism, as arising from puncture of the gluteal artery just where this vessel emerges from the pelvis—the occasion for double ligature which suggested John Bell's famous procedure. But hæmorrhage from the internal mammary artery may be more readily controlled by compression, as in the case of an intercostal artery; a small bag being introduced over the wound, and then stuffed with lint, the bag is withdrawn so as to effectually compress the vessel against the posterior aspect of the sternum.

LIGATURE OF THE COMMON CAROTID.—*Surgical Anatomy.*—The right and left common carotid arteries differ only in part of their course; that portion of the latter vessel which extends from its origin on the arch of the aorta to the left sterno-clavicular articulation, or the thoracic portion of the left common carotid. But this part of the left carotid artery is never selected for ligature.

The common carotid on the *right* side, and the cervical portion of the *left* common carotid, extends from behind the *sterno-clavicular* articulation to the upper border of the *thyroid cartilage;* where it divides into *external* and *internal* carotid arteries. (Fig. 151.) The artery has an *oblique direction* upwards and outwards; corresponding

to a line drawn from the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process of the temporal bone. It seems to have an inclination backwards, superiorly, owing to the projection forward of the larynx, in that situation. The artery with the internal jugular vein and pneumogastric nerve are enclosed in a common membranous *sheath*, continuous with the deep cervical fascia. The vein, within this sheath, is situated along the outside of the artery, a thin cellular partition only intervening; the nerve lies behind and between the two vessels. Thus so far isolated,

FIG. 151.*



the artery is deeply placed at the lower part of the neck, and more superficial above. *Below*, the sheath is *covered* by the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, and crossed by the omo-hyoid muscle obliquely upwards just below the cricoid cartilage. Superficial to these muscles is the skin and superficial fascia, and a small portion of the platysma myoides as it passes upwards from the clavicle to the lower jaw; the deep cervical fascia ensheathing the muscles and passing down behind them, continuous with the sheath of the vessels, into the thorax. Crossing the sheath is the middle thyroid vein. *Above* the cricoid cartilage, the artery is covered only by the skin and superficial fascia, platysma and deep fascia. Crossing the sheath here are the superior thyroid veins, which sometimes form a plexus in this situation. The descendens noni, a branch of the hypoglossal nerve, lies on the sheath of the vessels from above downwards, inclining from the outer to the inner side. Occasionally, this nerve runs within the sheath, and between the artery and vein. *Posteriorly*, the artery throughout its course is supported by the transverse pro-

* Common Carotid Artery, and its Branches.—*a*, common carotid; *b*, internal jugular vein; *c*, internal carotid; *d*, external carotid; *e*, upper thyroid branch; *f*, lingual; *g*, facial; *h*, internal maxillary. (From Quain, "Anatomy of the Arteries," part view, reduced.)

cesses of the cervical vertebræ; a thin stratum of musclo intervening, consisting of the longus colli and scalenus anticus. The sympathetic and recurrent laryngeal nerves, and inferior thyroid artery, are also in relation with the posterior aspect of the artery. On the *inner* side of the artery, below, lie the trachea with the thyroid body, which often overlays the vessel; above, the larynx and the pharynx. On the *outer* side is a chain of lymphatic glands, between the sheath and the inner border of the sterno-mastoid muscle, which corresponds to the artery in the upper part of its course. Within the *sheath*, the large internal jugular vein is in immediate relation, on the outer side of the vessel.

Fig. 152.

Operation.—The patient should be placed in the recumbent position, with the head thrown back, and the face turned a little from the side of operation; thus exposing the side of the neck. The *apex* of the carotid triangle, where the omo-hyoid muscle crosses the artery, is selected, if possible, as the seat of ligature; the inner margin of the sterno-mastoid muscle being the guide to the artery. An incision, from two to three inches long, on the inner edge of this muscle, should be so placed that the centre about corresponds to the lower border of the cricoid cartilage. (Fig. 152.) The skin, superficial fascia, and platysma are thus divided. Turning the head a little so as to relax the sterno-mastoid, the deep fascia must be cautiously divided, and the sheath of the vessels exposed, with the omo-hyoid crossing it. The thyroid veins, turgid with blood, passing across the sheath of the vessels, and the descendens noni lying in front of the sheath, are drawn to either side of the wound with retractors by an assistant. The operator introducing his finger into the wound, feels the artery beating between the trachea and sterno-mastoid muscle. The sheath is now opened in the usual way, by a pinch up with the forceps and lateral application of the knife; the aneurism-needle should be gently insinuated, on the outer side of the artery, between it and the vein, taking care not to include the pneumogastric nerve in dipping the needle round the vessel; the ligature is then drawn through and secured, without disturbing the vessel.

The operation *lower* down in the neck necessitates the division of the sternal portion of the sterno-mastoid muscle. The sterno-hyoid and thyroid muscles may be drawn to the outer side. Any thyroid veins and the internal jugular, which, on the left side, inclines to the front of the artery, will also thus be avoided; and the ligaturo is then passed as above.

Ligature of the External, and Internal, Carotid.—*Surgical Anatomy.*—(1.) The *external* carotid arising from the *bifurcation* of the common carotid, opposite the upper border of tho thyroid cartilage, extends upwards to the neck of the *condyle* of the lower jaw, between it and the mastoid process; there dividing into two branches, the temporal and internal maxillary arteries. (See Fig. 151.) In this

course, it lies, at first, on the *inner* side of the internal carotid, and then superficial to that vessel. But its *depth* varies below and above the *digastric muscle*, or a line drawn from the mastoid process to the hyoid bone.

Below that muscle or line, the external carotid is *covered* only by the skin and superficial fascia, the platysma, and deep fascia; then, passing beneath the digastric and stylo-hyoid muscles and hypoglossal nerve, which cross obliquely, the artery enters the substance of the parotid gland, beneath the facial nerve and the external jugular vein. Here then the artery is deepest, and inaccessible. *Posteriorly*, the artery rests on the pharynx and the superior laryngeal nerve; and above the angle of the jaw, on the styloid process and glosso-pharyngeal nerve, which separates it from the internal carotid. To the *inner* side is the pharynx, and above, the ramus of the jaw and stylo-maxillary ligament. On the *outer* side, the internal carotid lies parallel with the external carotid, at the origin of the two vessels; but this relationship is soon lost, as the external vessel becomes more superficial in passing to its destination. More externally, the inner edge of the sterno-mastoid muscle corresponds to the artery.

(2.) The *internal* carotid, arising from the *bifurcation* of the common trunk (see Fig. 151), extends upwards to the *carotid foramen* in the temporal bone; and there, passing through the carotid canal in that bone, it enters the *cranium*. The cervical portion, limited by the carotid foramen, varies in *depth*—like the external carotid—with its relation to the *digastric muscle*. Below that muscle, the artery is *covered* only by the skin and superficial fascia, platysma, and deep fascia; then passing beneath the external carotid, separated by the styloid process and glosso-pharyngeal nerve—at the angle of the jaw—it lies under the deep surface of the parotid gland, until it enters the carotid foramen. *Posteriorly*, the artery rests on the transverse processes of the upper cervical vertebræ; the rectus anticus major muscle, sympathetic and superior laryngeal nerves, intervening. *Internally*, the pharynx and tonsil are in contact; and the ascending pharyngeal artery runs up, on the pharynx, between the vessel and the external carotid. *Externally*, the internal jugular vein runs side by side with the artery, and the pneumogastric nerve behind and between the two; these structures having the same relation as to the common carotid, of which the internal carotid seems to be the continuation. The hypoglossal nerve comes forward between the vein and artery, and passes inwards over the latter to gain the lower border of the digastric muscle, over the external carotid; thus crossing both arteries superficially. The inner margin of the sterno-mastoid muscle corresponds to the artery, externally.

Operation.—The neck must be well exposed, as for the ligature of the common carotid. Guided by the *sterno-mastoid*, an incision along its inner margin—from the angle of the jaw to just above the level of the thyroid cartilage—will lead down to the *internal* carotid (see Fig. 152); and a little more internally, to the *external* carotid (see Fig. 152). The digastric muscle and hypoglossal nerve crossing the latter near the upper angle of the incision, identify this artery. A small aperture is made in the sheath of the vessel to be ligatured, and an aneurism-needle passed betwixt it and the vein; as in the operation on the common carotid.

Ligature of the Lingual Artery.—*Surgical Anatomy.*—*Arising* from the inner aspect of the external carotid, between the superior thyroid and facial branches, the lingual passes slightly upwards and inwards to the great cornu of the hyoid bone; and above it, continues forwards beneath the hyoglossus muscle, at the interior border of which it gives a branch—sublingual—to the sublingual gland; and then *terminates* as tho *ranine* branch, along the outer side of the genio-hyoglossus, extending to the tip of the tongue. Having this somewhat tortuous *direction*, the artery is comparatively superficial below and above the great cornu of the hyoid bone, in this part of its course being *covered* only by the skin, platysma, and fascia; but it is then crossed by the digastric and stylo-hyoid muscles passing to the body of the hyoid bone, and the artery enters deeply beneath the muscles; it is concealed entirely by the mylo-hyoid, as well as overlaid in part by the hyoglossus. *Resting* on the middle constrictor of the pharynx, the vessel afterwards lies on the genio-hyoglossus muscle, *beneath* the hyoglossus, and in its course as the ranine artery under the tongue. The hypoglossal nerve, winding round the lower border of the posterior belly of the digastric muscle, passes upwards beneath it, and approaching the posterior margin of the hyoglossus muscle, the nerve is there situated above the lingual artery; continued *over* that muscle to its anterior margin, the nerve has become inferior, and there sinks into the fibres of the genio-hyoglossus muscle, the artery-ranine lying on the muscle.

Operation.—The lingual artery can be more readily reached, if necessary, in the *superficial* part of its course; and the upper border of the great cornu of the hyoid bone will guide to the artery in an accessible situation. Having placed the head so as to expose the digastric triangle under the jaw, an oblique incision should be made from below the symphysis of the jaw, over the cornu of the hyoid bone, to the border of the sterno-mastoid. (See Fig. 152.) Dividing the skin, platysma, and fascia, any veins in the way and the tendon of the digastric may bo drawn upwards, and the artery sought, above the cornu and below the nerve. Care must be taken not to penetrate tho pharnyx—superior constrictor, on which the vessel here rests; and such caution is especially necessary, as the thin pharyngeal bag rises and subsides under the knife. Application of the ligature presents no special difficulty.

Ligature of the Subclavian.—*Surgical Anatomy.*—The right and left subclavian arteries differ only in part of their course; that portion of the latter vessel which extends from the arch of the aorta to the inner margin of the first rib at the root of the neck, or the *thoracic* portion of the left subclavian. But this part of the left subclavian artery is never selected for ligature.

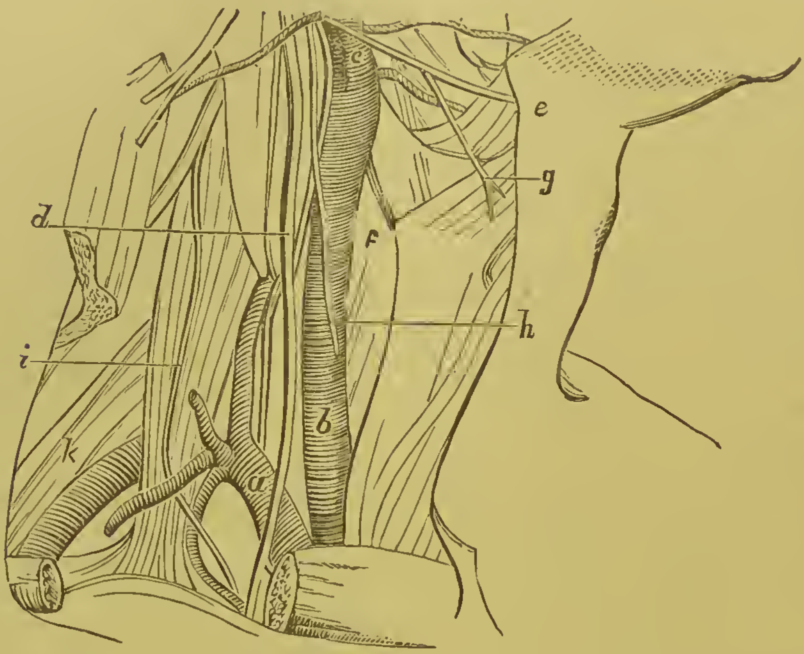
The subclavian on the *right* side extends from behind the *sterno-clavicular* articulation, and the *cervical portion* of the *left* subclavian from the *first rib*, outwards to the *lower margin* of the first rib; *arching*, in its course, over the apex of the lung and pleura, and passing between the scaleni muscles.

Either artery, in this course, may be divided into *three portions*, for the convenience of description, surgically as well as anatomically. The *first* portion extends from the sterno-clavicular articulation—or first rib, on the left side—to the inner border of the anterior scalenus;

the *second* portion, beneath the scalenus; and the *third*, from the outer border of that muscle to the lower margin of the first rib. The anterior scalenus muscle is thus the boundary between the inner and outer portions of the subclavian artery, and of the middle portion beneath that muscle.

(1.) *Internal* to the anterior scalenus, the artery ascends slightly outwards, and is deeply placed. (Fig. 153.) *Covered* by the skin, platysma, and fascia, it is also concealed by the clavicular origin of the sterno-mastoid and by the sterno-hyoid and sterno-thyroid muscles

FIG. 153.*



Deeper still, and immediately in front of the artery crossing it from above downwards, are the pneumogastric nerve and the internal jugular vein; the latter having inclined outwards from the common carotid in the lower part of the neck, leaves a triangular interval between these two vessels. Along the base of this interval lies the subclavian artery; the pneumogastric descends vertically over it, and sends off its recurrent laryngeal branch, which hooks up behind the vessel. *Posteriorly*, the artery is opposite to the transverse processes of the vertebræ, and longus colli muscle, but separated by a cellular interval; in which the trunk of the sympathetic and recurrent laryngeal nerve are in more immediate relation, the latter having hooked round the artery. *Inferiorly*, the artery lies on the pleura; and lower down, the corresponding portion of the subclavian vein runs transversely inwards to join the internal jugular, in forming the innominate vein, behind the sterno-clavicular articulation.

* Subclavian Artery and Nerves.—*a*, subclavian trunk, giving off its branches, vertebral (ascending), internal mammary (descending), and the thyroid axis, showing two of its branches—the supra-scapular and transverse cervical—cut; *b*, common carotid; *c*, external carotid. Nerves: *d*, pneumogastric, with recurrent branch passing round the subclavian artery; *e*, hypoglossal; *f*, superior laryngeal branch of the pneumogastric; *g*, thyroid-hyoid branch of the hypoglossal; *h*, descendens noni branch, cut; *i*, phrenic nerve, on the anterior scalenus muscle; *k*, brachial plexus. (Ellis, "Illustrations of Dissections," reduced.)

Three *branches* arise from the subclavian, in this part of its course: the vertebral, ascending to the head through the foramina in the transverse processes of the cervical vertebræ; the internal mammary, descending to the chest; and the thyroid axis, a short thick trunk arising from the front of the artery, and dividing into the inferior thyroid, the supra-scapular, and transverse cervical branches.

The first part of the *left* subclavian is more vertical, the internal jugular and pneumogastric incline inwards over the common carotid, the recurrent branch is given off round the arch of the aorta; and thus the artery may be somewhat more free than on the right side.

(2.) *Beneath* the scalenus, the subclavian reaches its highest point above the clavicle, is transverse and curved in direction, and placed less deeply than in the first part of its course. *Covered* by the skin, platysma, and fascia, it has also in front of it the clavicular origin of the sterno-mastoid, and the anterior scalenus muscles; the latter being attached by a flat narrow tendon to the inner border and upper surface of the first rib. (See Fig. 153.) Between the two muscles, the phrenic nerve descends obliquely inwards, lying on the scalenus. *Posteriorly*, the artery rests on the posterior scalenus muscle; thus passing between the scaleni. *Above* the artery, in this interval, are the large trunks of the lower cervical nerves which form the brachial plexus. *Below*, the artery curves over the apex of the lung and pleura. The subclavian vein runs transversely inwards, below the level of the artery; the anterior scalenus muscle intervening between the two vessels.

One *branch* only arises from this part of the subclavian, namely, the superior intercostal artery from its posterior aspect, which turns downwards over the neck of the first rib to supply the first two intercostal spaces. On the left side, this branch springs, commonly, from the first portion of the subclavian; thus making four, or all the branches of this artery, to arise from that part of the vessel.

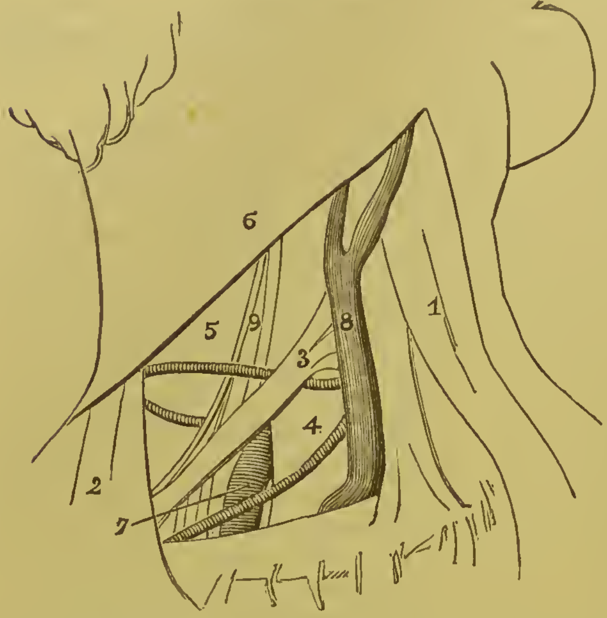
(3.) *Beyond* the scalenus, the subclavian descends to the *lower margin* of the first rib, and is more superficial than in either of the previous portions of its course. It is situated in the lower or clavicular part of the posterior triangular space of the side of the neck; behind and partly below the middle third of the clavicle. But the depth of the artery below this bone will vary with the elevation of the shoulder, whereby it may sink altogether below that level.

It lies in a small triangular space, bounded internally by the outer border of the sterno-mastoid concealing the anterior scalenus; superiorily, by the omo-hyoid muscle passing slantingly upwards and inwards to the sterno-mastoid and then beneath it; and inferiorly, by the clavicle. (Fig. 154.) This small space is commonly not more than one inch and a half in extent, from the sterno-mastoid outwards, and about the same from above downwards along that muscle. But these dimensions will vary with the length of the clavicular origin of the sterno-mastoid, and the clavicular attachment of the trapezius. Usually attached, respectively, to the inner and outer third of the clavicle, the muscles in some persons may nearly meet along the whole length of this bone. Then again, the height to which the omohyoid rises above the clavicle considerably affects the vertical length of the space. Its *depth* varies naturally with the thickness of the neck, and is altered by the position of the shoulder.

This portion of the subclavian is *covered* only by the skin, platysma,

and fascia, with some of the superficial descending branches of the cervical plexus; but below, the artery is under cover of the clavicle, and crossed, beneath this bone, by the supra-scapular branch from the thyroid axis. The transverse-cervical branch traverses the upper angle, at the junction of the omo-hyoid and sterno-mastoid muscles. Here also, the external jugular vein coming downwards over the last-named muscle, enters the space to open into the subclavian vein. The artery *rests* on the pleura and upper surface of the first rib; on which, between the vessel and the tendon of the scalenus, a *tubercle* may be felt—the guide to the artery. *Above* is the brachial plexus, consisting of three nervous cords, supported by the posterior scalenus muscle; *below* lies the subclavian vein.

Fig. 154.*



No branch arises from this, the third portion of the artery.

Operation.—Internal to the scalenus.—A transverse incision over the clavicular origin of the sterno-mastoid leads down to the vessel in this part of its course. (See Fig. 152.) But a vertical incision also along the inner border of the muscle may be added, if necessary, for space; and the V-shaped flap of integument raised, with the platysma and fascia. The clavicular portion of the muscle and the sterno-hyoid and sterno-thyroid muscles beneath, are then to be divided transversely, just above the clavicle, and the vessel exposed. The internal jugular vein may be drawn outwards and guarded with a retractor, and the pneumogastric nerve being avoided, the aneurism-needle armed with a ligature should be passed around the artery from below upwards.

Beneath the scalenus.—A V-shaped incision should be made, but with the angle looking inwards. (See Fig. 152.) Thus, a transverse incision over the clavicular origin of the sterno-mastoid, from two to three inches in length, is met by a vertical incision about two inches long, rather external to the outer border of the sterno-mastoid; and the flap of skin, platysma, and fascia is raised upwards and inwards. The external jugular vein may be conveniently drawn outwards. The clavicular portion of the sterno-mastoid must then be divided inwards as far as may be necessary to expose the anterior scalenus clearly. The phrenic nerve lying on that muscle, and the internal jugular vein

* Posterior Triangle of the Neck, lower portion. 1. Sterno-mastoid muscle. 2. Trapezius. 3. Posterior belly of the omo-hyoid. 4. Anterior scalenus. 5. Middle scalenus. 6. Upper boundary, beyond the subclavian triangle. 7. Subclavian artery—its third part. 8. External jugular vein, joining the subclavian below. 9. Nerves of brachial plexus. (Blandin, "Surgical Anatomy," part view, reduced.)

along its inner border, are to be drawn inwards, and guarded with a retraetor. By partially dividiug the muscle with caution, from without inwards, the artery comes into view. The aneurism-necdle should bo passed from below upwards.

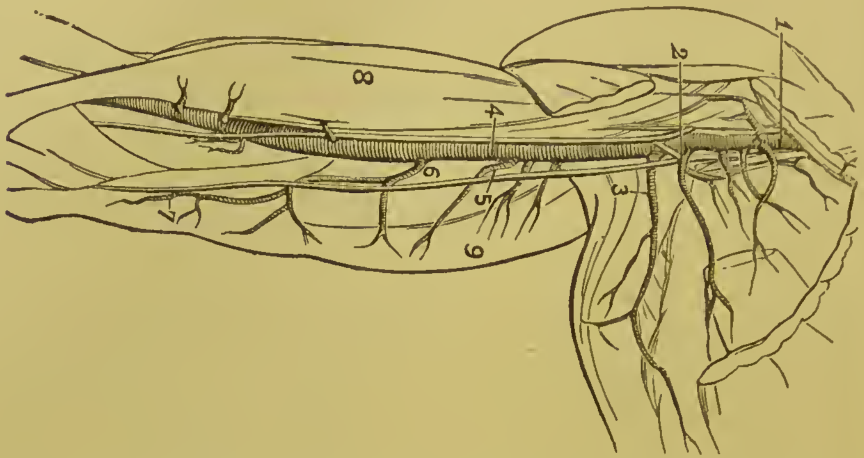
Beyond the sealcnus.—The shouldcr being depressed as low as possiblc, and the skin of the ueek drawn down over the clavicle, a transverse incision is made along the claviele, cxtending from thc border of the sterno-mastoid outwards to the trapezius muscle, and in depth down to thc bone. (See Fig. 152.) The skin, platysma, and fascia are thus divided. On allowing the integumcnts to resume their plaee, the ineision will rise to just above and parallel to the clavicle. If therc be reason, as already explained, to suppose that the artery lies decply, a vertical incision may be added, as in figure, along the outcr border of the sterno-mastoid muscle, and meeting thc trausverse onc below at a right angle. The sterno-mastoid or trapczius approaching eaeh other along the clavicle in some cases, either or both these museles may be herc divided sufficiently to reaeh the artery on the first rib. The external jugular vein should be drawn inwards, and the decp cervical faseia cautiously divided to expose the artery. The supra-scapular artery running outwards ncarly uuder the clavicle, must be drawn down, and the omo-hyoid musclc upwards and outwards, thus also guarding the transverse cervical artery at about the junction of the omo-hyoid aud sterno-mastoid museles—the upper augle of the triaugular spaee in whieh the subclavian lies. This vessel, fawn-eoloured, will now be fairly seen; with the three white eords of the braehial plexus above, and the large, turgid, blue subclavian veiu below. On passing the finger down the anterior scalenus, the *tubercle* on the upper surface of the rib can be felt, aud thus the situation of the artery ascertained; lying, as it does, on the *outer* side of the tuberele. Avoiding the subclavian vein, the aneurism-needle should be insinuated between it and the artery, but eare must also be takcn not to include the lowest of the three uervous cords, as the point of the needle emerges on the opposite side. The depth and narrowness of the spaee, in some eases, may render this proceeding perplexing, and considerable difficulty may be experienced in fixing the ligature, it bcing perhaps impossible to reach the vessel with both forefingers. As a substitute, Liston recommended a *serre nœud* to be used—a strong wire, perforated or notched at one end. One only, or two, may be employed, or a double one, aecording to the judgment of the Surgeou. Of course, the effeet on the pulsation below should be aseertained before tightcning the ligature. A suture or two having been inserted to bring the edges of the wound together, the limb must be elevated and wrapped in cotton wool to maintain the circulation, as after thc ligature of any othcr main artery.

Ligature of the Axillary Artery.—*Surgical Anatomy.*—This vcsscl—the continuation of the subclavian—extcnds from the *lower border* of the first rib, through thc axilla, to the *lower border* of thc conjoincd tcndon of the latissimus dorsi and tcres major musclcs, at its inscrtion into the inner edge of thc bicipital groove of the humcrus. (Fig. 155.) *Curved* in its direction, the convexity of tho curvc looks upwards as the arm lics by the sidc of the body; but the artcry bccomes straight when thc limb is raised to a right-anglc with thc chest.

Thc axillary artery may be divided, for the convenience of descrip-

tion, into *three parts:* the *first* above, the *second* beneath, and the *third* below the small pectoral muscle. The two first portions are more deeply placed than the third portion of this vessel, which becomes superficial below the great pectoral muscle.

Fig. 155.*



Posteriorly, the artery lies *above*, on the first intercostal space and first digitation of the serratus magnus muscle, also the nerve to that muscle—the posterior thoracic or external respiratory of Bell—which, entering the apex of the axilla from the posterior scalenus, crosses underneath the artery. *Beneath* the small pectoral, the artery is opposite to, but not in contact with, the upper portion of the subscapularis muscle; *below* that boundary, the vessel lies on the lower part of the subscapularis, and then on the tendons of the latissimus and teres major muscles. *Anteriorly*, the artery is covered throughout its course by the skin and fascia; and above, by the clavicular portion of the great pectoral muscle, under which is a prolongation from the costo-coracoid membrane to the sheath of the vessels. The cephalic vein, lying in the interval between the deltoid and great pectoral muscles in front of the shoulder, sinks near the clavicle under the latter muscle, and crosses the axillary artery to open into the axillary vein. It thus penetrates the costo-coracoid membrane, which is also perforated by the acromial thoracic artery—a short trunk from the front of the axillary, and by the outer of the two anterior thoracic nerves—a small branch from the outer cord of the plexus, and which crosses inwards over the axillary artery to enter the under surface of the great pectoral muscle. The inner anterior thoracic nerve—a small branch from the inner cord—turns upwards between the artery and vein to enter the under surface of the small pectoral muscle.

Beneath the small pectoral, the artery is covered by that muscle and the superimposed part of the pectoralis major. The portion of artery below the small pectoral is overlaid by the lower border of the great pectoral muscle, and then only by the skin and fascia, superficial

* Axillary and brachial arteries. — 1. Axillary artery. 2. Long thoracic branch. 3. Subscapular branch 4. Brachial artery. 5. Superior profunda branch. 6. Inferior profunda branch. 7. Anastomotic branch. 8. Biceps muscle. 9. Triceps nerves—median crossing the artery; ulnar, below. (Quain, "Arteries," reduced.)

and deep. On the outer side, the coraco-brachialis muscle lies along this portion of the artery, thus completing its muscular relations.

Enclosed in a common *sheath* with the artery are—the axillary vein to its inner side, and the two cords of the brachial plexus, lying to the outer side of the artery *above* the small pectoral. *Beneath* that muscle they assume a new arrangement. The lowest, or inner nervous cord, passes to the inner side of the artery, separating it from the vein ; and either cord furnishes a fasciculus, which uniting form a third cord *behind* the vessel. Near the lower border of the small pectoral, a fasciculus from either primitive cord, *outer* and *inner*, form the median nerve which passes to the outer side of the artery, the fasciculus from the inner cord having crossed *over* the vessel to join that from the outer cord. Thus the artery is surrounded with nerves in this the second portion of its course, or beneath the small pectoral muscle. Below this muscle, the vessel is even more entirely surrounded with nerves. On the outer side lie the external cutaneous as well as the larger-sized median nerve, both derived from the outer cord ; on the inner side, between the artery and vein are the ulnar, internal cutaneous, and nerve of Wrisberg, all derived from the inner cord ; and behind the artery are the musculo-spiral and circumflex nerves, both derived from the posterior cord. Three subscapular nerves are also derived from the posterior cord, but these muscular branches have no immediate relation to the artery.

Six *branches* are given off by the axillary artery : the superior thoracic, opposite the first intercostal space ; the acromial thoracic to the pectoral and deltoid muscles ; the alar thoracic, an inconstant branch to the axillary glands ; the long thoracic under the lower border of the great pectoral muscle to about the sixth intercostal space ; the subscapular branch along the lower border of the muscle so named ; and the circumflex branches anterior and posterior, the latter being the larger, encircling the neck of the humerus.

Operation.—Above the small pectoral muscle. An incision is made just under the clavicle, extending from near its sternal end to the interval between the pectoral and deltoid muscles, on the inner side of the acromion. (Fig. 156.) The pectoral muscle is next divided to this extent, and the costo-coracoid sheath cautiously opened; then the cephalic vein being drawn to the outer side, thus also protecting the cords of the brachial plexus more deeply placed, the axillary vein is drawn towards the chest, and the ligature-needle passed under the artery from within outwards. If the trunk of the acromial thoracic artery be wounded, it will bleed almost as profusely as an aperture in the axillary trunk ; and the inclusion of either anterior thoracic nerve should be avoided in passing the ligature.

Fig. 156.

Beneath the small pectoral muscle, the artery should not be selected

for operation, owing to its greater depth in that part of its course, and more intimate relation to the cords of the brachial plexus. But the line of incision is indicated in the figure.

Below the small pectoral, the artery is most superficial and accessible, particularly beyond the great pectoral muscle. Abducting the arm and bending the forearm will bring the vessel even more to the surface, and also relax the nervous cords surrounding it. An incision about three inches long may be made from the lower border of the great pectoral muscle, downwards over the course of the artery, along the border of the coraco-brachialis muscle, dividing the skin and fascia. (Fig. 157.) The deep or aponeurotic fascia must then be divided. By drawing the median nerve to the outside, and the vein to the inside of the wound, the artery can readily be discovered, and separated so as to pass the ligature-needle without including either of the adjoining nerves which lie around the vessel.

FIG. 157.

LIGATURE OF THE BRACHIAL ARTERY.—*Surgical Anatomy.*—In continuation of the axillary, the brachial artery commences at the *lower border* of the tendon of the latissimus and teres major muscles, and terminates just below the bend of the elbow, opposite the *neck* of the radius; where it divides into the *radial* and *ulnar* branches. (See Fig. 156.) In *direction*, this artery winds round the humerus, from above at its internal aspect, to below in front of that bone and the elbow-joint. Throughout its extent, the vessel is superficial; except at the elbow, where it sinks into the flexure of the joint.

Covered throughout its course by the skin, superficial and deep fascia, at the elbow the brachial artery is also overlaid by a prolongation from the tendon of the biceps muscle, and by the median basilic vein horizontally crossing the line of the artery. *Behind*, from above downwards, it has the following relations. As the vessel lies inside the humerus, it rests on the long head of the triceps muscle and then on its inner head; inclining to the front, it rests on the insertion of the coraco-brachialis and then on the brachialis anticus muscle, to the bend of the elbow. Thus the artery is supported by muscles throughout its course. At the *outer* side, the brachial corresponds, above, to the coraco-brachialis, overlaid by the biceps, to about the middle of the arm, or opposite the insertion of the deltoid externally; and in the remainder of its extent, to the biceps only, as the vessel lies on the brachialis anticus. In the bend of the elbow, the tendon of the biceps passes down, on the outer side of the vessel. In immediate relation are two venæ comites, one on either side of the artery, and which encircle it with communicating branches; these veins taking the place of the single large axillary vein above, on the inner side of the axillary artery. A superficial vein—the basilic—overlies the brachial, separated by the deep aponeurotic fascia, to about the insertion of the coraco-brachialis, or the middle of the arm; there penetrating the fascia, this vein becomes continuous with the axillary.

Certain nerves grouped around the axillary artery, in its course beyond the small pectoral muscle, still remain in immediate relation with the brachial, and are thus disposed of. The median nerve, lying to the outer side as low as the insertion of the coraco-brachialis muscle, then descends over, or under, the artery, to gain its inner side about two inches above the elbow; and in the bend of the joint, it is placed on the inner side, about half an inch apart, as the vessel inclines outwards to the neck of the radius. This nerve is, otherwise, in contact with the artery throughout its course. The ulnar nerve continues close to the inner side of the brachial artery as low as the insertion of the coraco-brachialis; but there inclining inwards, it passes through the inner intermuscular septum, and, imbedded in the triceps muscle, reaches the interval between the olecranon and inner condyle, thus losing all relation to the artery. The internal cutaneous is also to the inner side at first, it then lies over and on the artery as far as about the middle of the arm; there, perforating the deep fascia, it loses this intimate relation; its anterior branch, with the basilic vein, still, however, overlaying the artery. The musculo-spiral nerve remains posterior for about two inches only; then passing backwards and outwards between the inner and outer heads of the triceps, it winds round the humerus and ceases to have any relation to the artery.

Three named *branches* are given off from the inner side of the brachial: the superior profunda, arising near the lower border of the teres major tendon, winds backwards and accompanies the musculo-spiral nerve; the inferior profunda passes off opposite the insertion of the coraco-brachialis, with the ulnar nerve to the interval between the olecranon and inner condyle; and the anastómotic, which arises an inch or two above the elbow, has the same destination.

Operation.—The brachial artery may be ligatured in either part of its course.

In the *first* portion, or that which corresponds to the *coraco-brachialis* muscle, the artery is reached as in the third portion of the axillary, and the brachial being less encompassed with nerves, it is more accessible. An incision along the border of the muscle (see Fig. 157), and dividing the skin and fascia, leads down to the vessel. The deep or aponeurotic fascia is then divided, and on drawing the median nerve to the outer side, the artery, with its venæ comites, is exposed, with the internal cutaneous nerve to the inner side or in front of the vessel. Separating this nerve, the aneurism-needle may be passed round the artery from either side most convenient to the operator, avoiding, perhaps, the venæ comites. But I have frequently included one or both such veins in ligaturing a second-sized artery, and without any evil consequence.

The *second* portion of the brachial—that in relation to the *biceps*—is ligatured in a similar manner. An incision, from two to three inches long, is made on the inner border of this muscle (Fig. 157), avoiding the basilic vein; having reached the artery, the median nerve, crossing it obliquely or at the inner side, may be drawn to that side, with the vein. The artery, with its venæ comites, will thus be exposed, and the needle readily passed.

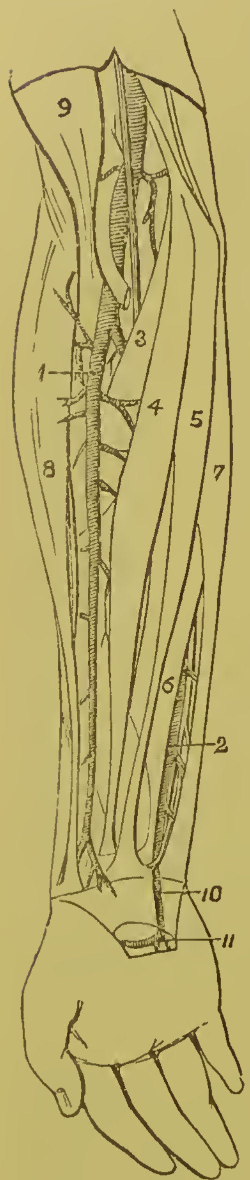
The *third* portion of the brachial—that in the *bend of the elbow*—requires ligature only for wound of the artery in this situation. The external wound will guide to the aperture in, or the division of, the

vessel; itself lying on the inner side of the biceps tendon with the median nerve more internal, by about half an inch.

Aneurismal varix and varicose aneurism at the bend of the elbow, owing to communication of the brachial artery and median basilic vein, are both analogous conditions as to the operation for ligature *in situ;* but they present certain difficulties not met with when the artery alone is wounded. These complications have already been noticed—ANEURISMAL VARIX.

LIGATURE OF THE RADIAL ARTERY.—*Surgical Anatomy.*—The radial artery extends from the *bifurcation* of the brachial, opposite the *neck* of the *radius*, to the *end* of this bone; and thence posteriorly through the first interosseous space to the *palm* of the hand. It is thus found in the forearm, the back of the wrist, and palm. In *direction*, the continuation of the brachial, a line drawn from the centre of the bend of the elbow to the styloid process of the radius, will indicate the course of the radial in the forearm. More deeply placed above, between muscles, it becomes quite superficial below as it approaches the wrist.

FIG. 158.*



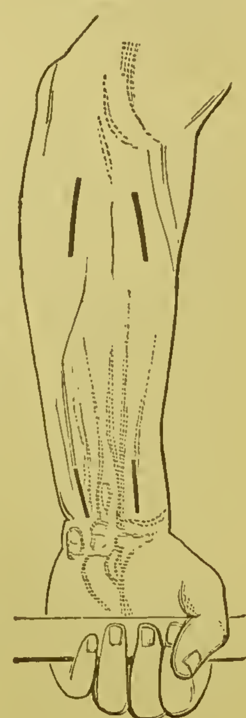
At first on the inner side of the radius, it soon lies over that bone, *resting* on the following muscles, in order, from above downwards: supinator brevis, tendon of pronator radii teres, radial origin of flexor sublimis, flexor longus pollicis, pronator quadratus; and on the end of the radius, above the wrist. In the *upper half* of this course, the artery runs *between* the fleshy bellies of the supinator longus externally, and the pronator teres internally, being slightly overlaid by the former muscle; in the *lower half*, it is *between* the tendons of the supinator longus and flexor carpi radialis. (Fig. 158.) The *radial nerve*—a terminal branch of the musculo-spiral in front of the external condyle of the humerus—passes down under cover of the supinator to the outer side of, but not in contact with, the artery as far as the insertion of the pronator teres; then lying by the side of the vessel, the nerve passes backwards under the tendon of the supinator and becomes cutaneous, thus losing any immediate relation to the vessel. Throughout its course in the forearm, the artery is *covered* only by the skin, superficial fascia, and the deep or aponeurotic fascia.

The named *branches* are three. The radial recurrent, a branch of some size, is given off transversely under cover of the supinator longus muscle; it supplies the muscles on the outer side of the forearm, and sends an

* Radial and Ulnar Arteries.—1. Radial artery, and nerve external. 2. Ulnar artery, and nerve internal. 3. Pronator radii teres muscle. 4. Flexor carpi radialis. 5. Palmaris longus. 6. Flexor sublimis. 7. Flexor carpi ulnaris. 8. Supinator longus. 9. Biceps. 10. Palmar portion of ulnar artery. 11. Continued as superficial palmar arch. (Quain, "Arteries," reduced.)

offset upwards to anastomose with the superior profunda branch of the brachial artery. The superficial volar, and the anterior carpal branches, arise just above the wrist.

Fig. 159.



Neither of these branches is important in the operation of applying a ligature to the radial trunk, except the first.

Operation.—In the *upper* or deeper part—an incision along the inner or ulnar margin of the supinator longus (Fig. 159), and through the deep fascia, will lead down to the artery, which is somewhat overlaid by that muscle; its fibres being distinguished by their vertical direction from those of the pronator teres, obliquely crossing the line of incision. Drawing the supinator, and with it the radial nerve, outwards, the artery is seen with its venæ comites, one of which commonly lies in front. In passing the needle, it is unimportant whether it be included and ligatured.

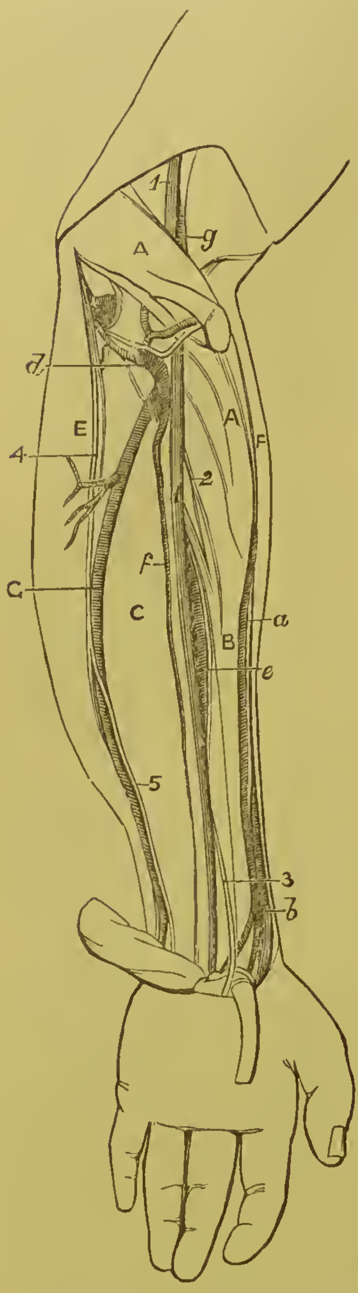
Lower down and superficial towards the wrist, an incision on the outer or radial side of the flexor carpi radialis tendon (see Fig. 159) leads to the vessel, under the deep fascia; lying about midway between this tendon and that of the supinator longus. The radial nerve is here quite out of the way, and the venæ comites are unimportant.

On the *back* of the *wrist*, and in the *palm*, the radial is tied only for Wound, and at the wounded point. In the former situation, as the artery passes from the end of the radius to the apex of the first interosseous space, it is crossed by the tendons of the three extensors of the thumb, successively; the extensor ossis metacarpi pollicis, and the extensors, primi and secundi internodii pollicis. Either of these tendons may guide to the wounded artery.

Ligature of the Ulnar Artery.—*Surgical Anatomy.*—The ulnar artery extends from the *bifurcation* of the brachial, opposite the *neck* of the *radius*, to the *end* of the ulna; thence into the *palm*, to join with the radial in forming the palmar arches, superficial and deep. In direction (Fig. 160), it arches from its commencement, inwards towards the ulna, and then downwards; thus not appearing to be the continuation of the brachial, although the ulnar is of larger size than the radial branch. More deeply placed above between muscles, it becomes quite superficial below as it approaches the wrist. At first, it *rests* on the insertion of the brachialis anticus into the coronoid process of the ulna; curving inwards and downwards, it lies on the flexor profundus. In the *upper half* of this course, the artery passes *between* the flexor profundus and four, of the five, muscles arising from the inner condyle of the humerus, which overlay and cross the vessel in their direction from within outwards; namely, the pronator radii teres, flexor carpi radialis, palmaris longus, and, beneath these three, the flexor digitorum sublimis. Then passing *between* the flexor carpi ulnaris and digitorum sublimis, and overlaid by the former muscle, in its *lower half* the artery is *between* the tendons of the flexor ulnaris and sublimis, the former tendon somewhat overlaying it. The *ulnar nerve* (see

Fig. 160), entering the forearm between the attachments of the flexor ulnaris to the inner condyle and olecranon, approaches the artery under cover of that muscle, and from about the middle of the forearm, continues down on the inner side of the vessel to the wrist; the nerve being even more concealed by the flexor ulnaris tendon. A small branch of this nerve descends in front of the lower part of the artery, to the skin of the palm; both artery and nerve passing over the annular ligament to the hand.

Fig. 160.*



The *median nerve*, to the inner side of the vessel at its commencement, crosses over to the outer side, and loses all relation to the artery. Throughout its course, the ulnar artery is *covered* by the skin, superficial and deep fascia, as well as by the superficial layer of muscles, above; below, only by the integuments.

The named *branches* of this artery are five: anterior ulnar recurrent, and posterior ulnar recurrent, both arising close to the elbow-joint and passing upwards to complete the anastomosis around the joint; the interosseous trunk, the largest branch given off, passes backwards to the interosseous membrane, there dividing into anterior and posterior branches; the metacarpal branch, arising near the wrist; and carpal branches, anterior and posterior, anastomosing with corresponding offsets of the radial, across the front and back of the wrist. Neither of these branches is important in the operation of applying a ligature to the ulnar trunk, except the third or interosseous.

Operation.—In the *upper* or deeper part, an incision along the radial border of the flexor carpi ulnaris will lead down to the vessel as it lies between this muscle and the flexor digitorum sublimis (see Fig. 159); the fibres of the former muscle being distinguished by their more vertical direction from those of the sublimis, obliquely crossing the line of incision. Separating these muscles, the ulnar nerve will probably be out of the way, internally; the artery is seen and the ligature passed. More difficulty, however, may be experienced in a

* Deep view of Arteries in the Forearm.—A, pronator radii teres muscle, B, flexor longus pollicis; C, flexor digitorum profundus; E, flexor carpi ulnaris; F, supinator longus; *a*, radial artery; *b*, cutaneous palmar branch; G, ulnar artery; *d*, recurrent branch; *e*, anterior interosseous artery; *f*, branch with median nerve; *g*, brachial trunk. 1. Median nerve. 2. Anterior interosseous. 3. Cutaneous palmar branch. 4. Ulnar nerve. 5. Cutaneous palmar branch. (Ellis, "Illustrations of Dissections.")

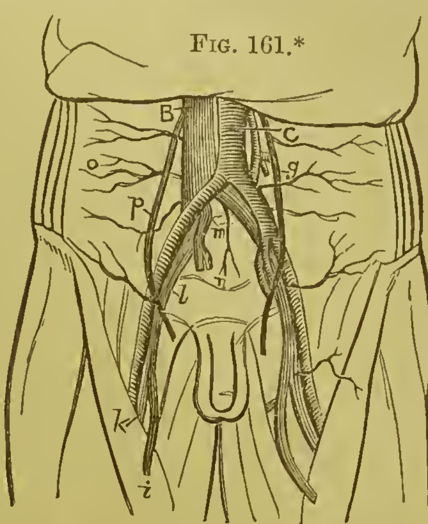
muscular arm, than with the corresponding portion of the radial artery.

Lower down and superficial towards the wrist, an incision (see Fig. 159) along the radial side of the flexor carpi ulnaris tendon leads to the vessel, under the deep fascia, and perhaps somewhat overlaid by the tendon. The ulnar nerve, more under cover, is drawn inwards, and the ligature passed between it and the artery.

On the *annular ligament* of the wrist, and in the *palm*, the operation in performed only for Wound, and at the wounded point.

Ligature of the Abdominal Aorta; and of the Iliac Arteries, Common, External, and Internal. — *Surgical Anatomy.* — The abdominal aorta, lying on the bodies of the lumbar vertebræ, inclines downwards to the left, and divides opposite the left side of the *fourth* lumbar vertebra, into two *common iliac* arteries, a right and a left. Either common iliac extends from the *bifurcation* of the aorta at this point, to opposite the intervertebral cartilage between the fifth or last lumbar vertebra and *base* of the *sacrum*—about two inches in length. (Fig. 161.) It there divides into two trunks or branches, *external* and *internal* iliacs: the external extending from this point, along the psoas muscle internally, to the lower border of *Poupart's ligament;* the internal extending from the same point, downwards and outwards on the pyriform muscle, to the *sacro-sciatic foramen*, about one inch and a half only in length, and smaller in size than the external iliac.

FIG. 161.*



The relation of the companion veins of these arteries is primarily important in their Surgical Anatomy. For the convenience of description the companion veins may be taken from above downwards.

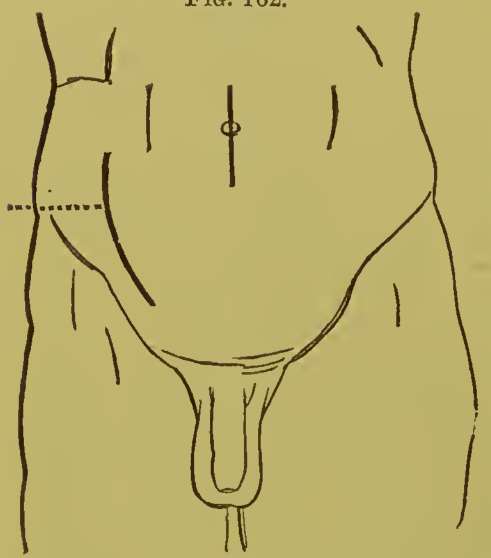
The *vena cava inferior*, lying on the vertebral column to the right of the abdominal aorta, is situated also to the outer side of the right common iliac artery at its commencement; dividing into two *common iliac* veins, the *right* continues on the outer side of the corresponding common iliac artery, and then passes beneath it, the left common iliac vein also passing beneath that artery above. Thus, the right common iliac artery lies on both these veins. The *left* common iliac vein, emerging from beneath the right artery, near the bifurcation of the aorta into both common iliacs, proceeds to the right or inner side of the left common iliac artery. The common iliac veins dividing at, or near, the bifurcation of the common iliac arteries; the *right external iliac* vein passes beneath the right external iliac artery to the left or inner side, where it is found at Poupart's ligament; the *left external iliac* vein lies entirely on the right or

* B, Vena cava, inferior; C, abdominal aorta, dividing into common iliac arteries; *l*, external iliac vein, with external iliac artery; *m*, internal iliac vein and artery; *o*, lumbar veins; *p* and *g*, spermatic veins. In the Thigh, *k*, femoral vein; joined by *i*, internal saphenous vein.

inner side of the left external iliac artery; and *both* the *internal iliac* veins are posterior to the corresponding internal iliac arteries, the right being somewhat external to its artery. The *muscles* in relation to these arteries are:—the *psoas*, on the outer side of the common iliac, at its termination; and then along the outer side of the external iliac to its termination, where the artery lies on the muscle at Poupart's ligament; this muscle is also near the internal iliac at its commencement, the external iliac intervening, while the *pyriform* muscle is behind this artery, on which it rests and on the lumbo-sacral nerve. In *front*, the *peritoneum* overspreads these three arteries, the internal iliac being contained in the fold that forms the posterior ligament of the bladder. Branches of the *sympathetic nerve*, proceeding from the aortic plexus in front of the lower part of the aorta, descend over the common iliac to the hypogastric plexus in the upper part of the concavity of the sacrum. The *inferior mesenteric* artery crosses the left common iliac. The *ureter* crosses sometimes the common iliac of its side, but generally the external and internal iliac, the former at its commencement, the latter lower down. The *external* iliac, near Poupart's ligament, is overlaid by the *spermatic vessels* and genital branch of the *genito-crural nerve*, proceeding obliquely inwards to the internal abdominal ring; it is crossed outwards by the *circumflex iliac vein*, and inwards, just above the ligament, by the *vas deferens* turning down on the inner side of the artery. The *abdominal parietes* are interposed between the aorta and iliac arteries and any operations on these vessels. They consist of the skin and superficial fascia; the tendon of the external oblique muscle, the internal oblique and transversalis muscles; the transversalis fascia, and peritoneum, which are loosely connected about the situation of the internal abdominal ring, where the spermatic cord passes through the abdominal walls.

Operation.—The iliac arteries, external, internal, and common, and even the aorta, may be reached by the same line of incision; commencing a little above the middle of Poupart's ligament—where the cord passes through, and carried outwards and upwards, nearly parallel with the ligament, to about the anterior superior spine of the ilium, or as far higher as may be necessary.

Fig. 162.



(1.) To reach the *external iliac*, this incision may terminate near the anterior superior spine. (Fig. 162.) The skin and superficial fascia only are first divided. The bluish-white tendon of the external oblique is next carefully divided to the same extent; exposing the spermatic cord as it passes under the lower margin of the internal oblique and transversalis muscles, in the lower angle of the incision. These muscles should now be divided with great caution, and the dull white transversalis fascia

recognized beneath. Raising this fascia with the forceps, at its thinnest and loosest part, near where the cord passes, an aperture is made, using the knife laterally; the finger should then be gently introduced between the fascia and peritoneum, and the former divided to the full extent of the external wound. The peritoneum, thus exposed, can then be detached with the fingers from its loose cellular connection in the iliac fossa, and drawn to the middle line, without damaging this membrane. Retractors are of use in retaining it there, or the fingers of an assistant may be preferable. The fawn-coloured artery is seen on the inner border of the psoas muscle, crossed generally by the white tape-like ureter above; unless the peritoneum be raised to a higher point, when the ureter, adhering to that membrane, will be raised with it. Lower down, the artery is crossed obliquely inwards by the spermatic vessels, and genital branch of the genito-crural nerve. Between these two points, the aneurism-needle can be passed most readily, with the usual precaution of introducing it between the artery and vein, here below.

(2.) The *internal iliac* is reached by the same incision, carried a little further upwards and inwards, above the dotted line. (See Fig. 162.) This artery also is crossed by the ureter, which may be raised with the peritoneum; the companion vein is somewhat posterior, and the external iliac vein outside, at the commencement of the vessel.

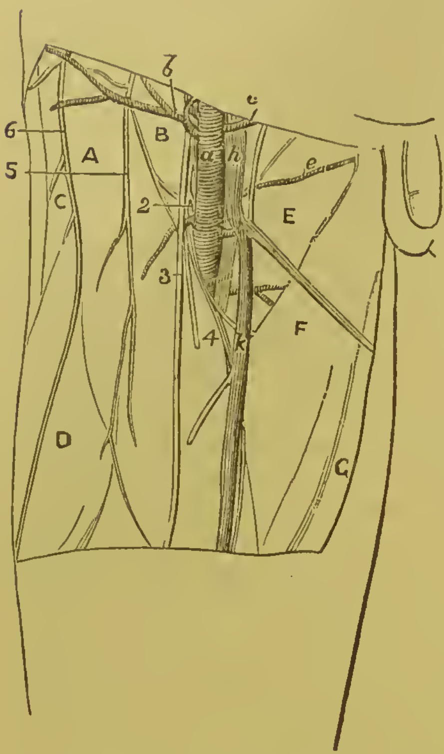
(3.) The *common iliac* can be reached by prolonging the incision upwards, and curving it inwards, to the extent of six inches (see Fig. 162); and there is always an advantage in having the incision below near the middle of Poupart's ligament—the loose connection of the transversalis fascia with the peritoneum, in that situation, facilitating the detachment of the latter membrane and raising it from the artery, which is the most critical part of the operation. The common iliac artery will be found by tracing up the external iliac along the border of the psoas muscle. But high up the trunk ceases to have this immediate relation to the muscle, and is most intimately related to venous trunks; on the right side, the common iliac vein lying externally, and both it and the left common vein passing behind the artery; while on the left side, the vein lies immediately internal to the artery. Their dark blue colour and large size contrast with the smaller, fawn-coloured artery. The ureter, like a white band, may perhaps cross the artery on either side; and the inferior mesenteric artery is always in front, on the left side; but generally both it and the ureter are out of the way.

(4.) The *abdominal aorta* may be reached in the middle line, as by the operation devised and performed by Sir A. Cooper. Taking the precaution of having the bowels well emptied, an incision was made through the linea alba, three inches in length, its centre corresponding to the umbilicus (see Fig. 162); the peritoneum was then opened to about the same extent—the intestines, having been emptied, did not protrude. Passing the finger down between their convolutions on to the spine, the aorta was felt beating strongly. The peritoneum was scratched through with the finger-nail, and the finger being insinuated under the aorta, an aneurism-needle was conveyed round it, and the ligature tied.

LIGATURE OF THE FEMORAL ARTERY, COMMON AND SUPERFICIAL.—*Surgical Anatomy.*—The femoral artery, a continuation of the external iliac, extends from the lower border of *Poupart's ligament* to the aperture

in the *adductor magnus* muscle, at the junction of the middle and lower third of the femur, internally. In the upper third of the thigh, the artery lies somewhat internal to the head of the femur; in the middle third, the remaining portion of the vessel inclines to the inner side of the shaft of the femur. In point of *depth* also, the first part is superficial and uncovered by muscle; the second part is deep and covered by muscle—the sartorius.

Fig. 163.*



In the *upper third* of the thigh, the femoral artery is contained in Scarpa's triangular space. (Fig. 163.) This space is bounded above by Poupart's ligament, forming the base; and laterally by the sartorius muscle on the outer side, and the adductor longus on the inner, meeting below in the apex. The artery passes down through the middle of this space, from mid-base to apex. But the length of the space, and consequently of this portion of the femoral, varies with the height at which the sartorius muscle inclines inwards and the breadth of that muscle. The artery *lies* on the psoas muscle, slightly tilted to its inner side under Poupart's ligament, then over the pectineus muscle separated by the profunda artery and vein in cellular tissue, and then on the femoral or companion vein, which intervenes between the femoral artery and adductor longus muscle at the apex of the space.

Entering Hunter's canal, the artery—in this the *middle third* of the thigh—*lies* on the adductor longus, and lastly, on the adductor magnus, to the aperture of exit in that muscle. (Fig. 164.) The artery is thus slung as it were, close to the femur, on the insertions of these two muscles into the linea aspera; and it is bounded externally by the vastus internus muscle, wrapping round the inner surface of the femur to the linea aspera.

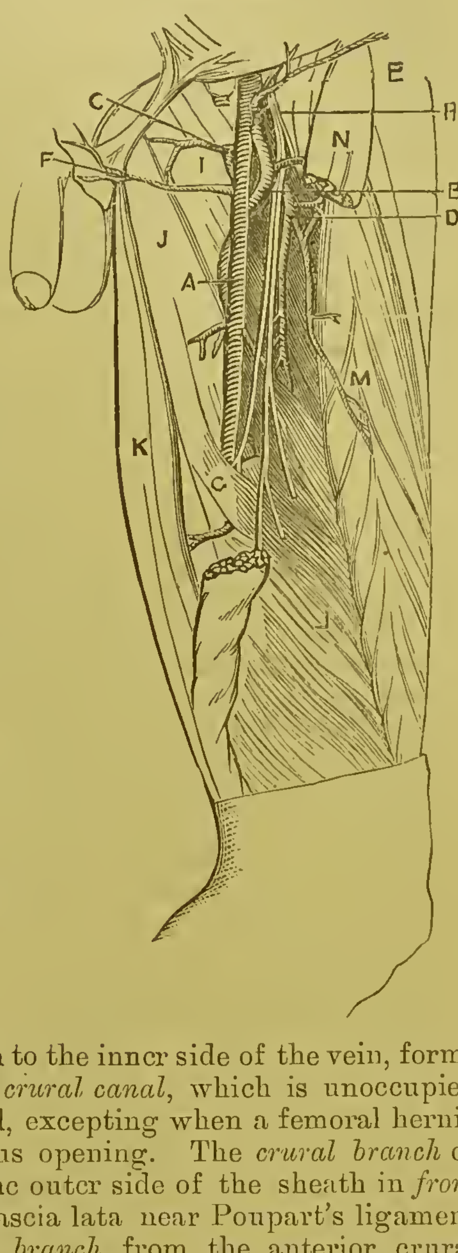
Covered in the *upper third* of the thigh—Scarpa's triangle, only by the skin and superficial fascia, the deep fascia or fascia lata, and by the inguinal glands; in the *middle third*—corresponding to Hunter's canal, the artery is also covered by the sartorius muscle, lying vertically over its course, and by an aponeurotic covering under this muscle, stretching across between the vastus internus and the tendons of the two

* Scarpa's triangle.—A, sartorius muscle; B, iliacus; C, tensor fasciæ latæ; D, rectus femoris; E, pectineus; F, adductor longus; G, gracilis. *a*, Femoral Artery; *b*, superficial circumflex iliac (the superficial epigastric and the deep circumflex iliac branches are adjoining); *c*, deep epigastric; *e*, superficial pudic, inferior; *k*, saphenous vein. Nerves: anterior crural, outside the artery. 2. Branch to pectineus. 3. Middle cutaneous. 4. Internal cutaneous. 5. Genito-crural. 6. External cutaneous. (Ellis, "Illustrations of Dissections.")

aforesaid adductor muscles, thus completing the *canal* through which the artery passes.

The femoral artery and vein, the latter lying to the inner side under Poupart's ligament, are enclosed in a loose tubular sheath, formed by a prolongation in front from the transversalis fascia of the abdominal wall, and behind, from the fascia iliaca; narrowing downwards around the femoral vessels, to about two inches in extent below the ligament, this sheath becomes continuous with the common *cellular sheath* which also invests the vessels *within* the special or *crural sheath*. The outer border of this sheath is straight, the inner oblique; and, from about half an inch below Poupart's ligament, the inner border corresponds to the *saphenous opening* in the fascia lata, itself about one inch and a half in length. The curved *falciform process* of Burns—bounding the outer margin of this opening—is that portion of the iliac part of the fascia lata which overlays the sheath of the femoral vessels; and the *upper cornu* of this process stretches inwards to join the base of *Gimbernat's ligament*—thus giving the outer margin of the saphenous opening a direction downwards and inwards. Behind the sheath of the femoral vessels, the pubic or inner portion of the fascia lata passes outwards over the pectineus muscle.

Fig. 164.*



Enclosed within the sheath, the *femoral vessels* are separated by a cellular septum; and another septum to the inner side of the vein, forms a third or inner compartment—the *crural canal*, which is unoccupied otherwise than by a lymphatic gland, excepting when a femoral hernia descends through it to the saphenous opening. The *crural branch* of the genito-crural nerve perforates the outer side of the sheath in *front* of the artery, and then pierces the fascia lata near Poupart's ligament to become subcutaneous. A small *branch* from the anterior crural nerve, above Poupart's ligament, descends *on* the artery. The long,

* Deep part of the Femoral Artery.—A, femoral artery; B, profunda, or deep femoral branch; C, internal circumflex, its commencement, passing backwards; D, external circumflex; E, superficial circumflex iliac; F, external pudic—inferior branch, superior branch above; G, aponeurosis over the lower part of the femoral artery; H, anterior crural nerve; I, pectineus muscle; J, adductor longus; K, gracilis; L, vastus internus; M, rectus femoris; N, sartorius, cut. (Quain, "Arteries." reduced.)

internal, *saphenous vein* on the inner aspect of the thigh, enters the saphenous opening to join the femoral vein; and some superficial *lymphatic vessels* also enter this opening to pass through the crural canal to the abdomen.

Continuing the course of the femoral vessels downwards in the thigh *below* the sheath, the vein still lies to the inner side of the artery, but winding behind it is then found on the outer side, at the upper border of the adductor longus; passing out of Scarpa's triangle, and with the artery entering Hunter's canal, the vein is still to the outer side, and it so passes through the opening in the adductor magnus.

The *anterior crural nerve*, under Poupart's ligament, lies on the outer side of the femoral vessels, but not enclosed in their sheath; being about half an inch distant, and separated by the tendon of the psoas muscle, on the inner side of which is the artery. The nerve lying in the groove between that muscle and the iliacus externally, it appears as a large, white, flat band, which soon divides into a superficial or cutaneous and a deep or muscular part.

The *superficial* part gives off the middle and internal cutaneous nerves of the thigh, and the internal saphenous nerve. The middle cutaneous pierces the fascia about three inches below Poupart's ligament, and dividing into two cutaneous branches which descend on the front of the thigh, it thus loses all relation to the artery. The internal cutaneous inclines obliquely inwards over the femoral artery, and divides into two branches: the anterior, descending on the sartorius muscle to the middle of the thigh, and there piercing the fascia lata; the internal, descending along the inner border of that muscle to pierce the fascia on the inner side of the knee. The internal or *long saphenous* nerve—the largest of the three superficial branches—descends on the outer side of the femoral artery; entering Hunter's canal under the vertical portion of the sartorius, it lies with the femoral vein still to the outer side of the artery, but somewhat posterior to the vein, and external to the cellular sheath containing it and the artery. At the opening in the adductor magnus, the saphenous nerve leaves the femoral vessels on their becoming popliteal; it is continued beneath the sartorius muscle to the inner side of the knee, there to pierce the fascia between the tendons of the sartorius and gracilis muscles. About the middle of the thigh, a communicating branch crosses inwards beneath the sartorius to join an offset of the internal branch of the internal cutaneous, and another from the anterior division of the obturator comes down in front of the abductor brevis to the lower border of the adductor longus. These three offsets here form a sort of *plexus*, beneath the fascia lata.

The *deep* or *muscular* part of the anterior crural nerve (see Fig. 164) divides into a brush of branches, which have more or less relation to the artery externally, towards the apex of Scarpa's triangle. Disappearing under the sartorius to enter the muscles, they supply that muscle, the rectus femoris, the vastus externus, and vastus internus—the branch to this muscle descending near the internal saphenous nerve, which it nearly equals in size; a small branch or two also crosses inwards behind the femoral vessels to the pectineus muscle.

Branches of the Femoral Artery.—The external pudic—two branches, an upper and a lower—pass inwards over the pectineus muscle, but under the fascia lata, to the skin of the penis, and the

scrotum or the labium pudendi; the superficial epigastric and superficial circumflex iliac pass, the one forwards through the saphenous opening in the fascia lata, and then upwards in the superficial fascia on the lower part of the abdomen, the other branch outwards across the psoas and iliacus muscles, under the fascia lata, towards the anterior superior spine of the ilium. The *deep femoral branch* or the *profunda* is nearly equal in size to the continuation of the femoral artery after giving off this, the largest branch. Hence the femoral trunk is spoken of as the common femoral artery, this large deep branch as the deep femoral, and the continuation of the common trunk as the superficial femoral artery. The deep femoral arises from the outer and posterior part of the common femoral artery, from an inch to two inches below Poupart's ligament. Inclining outwards over the iliacus muscle—and there giving from its outer side the external circumflex branch, and near it, the internal circumflex branch from the inner and back part of the vessel—the artery curves inwards and downwards over the pectineus, behind the femoral vessels, to gain their inner side; and passing behind the adductor longus, this deep artery continues down between that muscle and the short and great adductors; there dividing into three perforating branches, which penetrate these muscles close to the linea aspera, to reach the muscles at the back of the thigh.

The profunda *lies*, successively, in front of the iliacus and pectineus, the adductor brevis and adductor magnus, muscles. Placed at first to the outside, and crossing inwards behind the superficial femoral, it then runs parallel to it, but deeper by the thickness of the adductor longus muscle beneath what it passes. (See Fig. 164.) The deep femoral *vein* accompanies the course of the artery, but superficial to it; thus being interposed between the deep and superficial femoral arteries. And where the deep artery crosses inwards behind the superficial artery, the superficial femoral vein passes outwards between these vessels; thus making *both* femoral veins *between* the two arteries at that point—about the apex of Scarpa's triangle; just below which, the long adductor muscle separates the arteries and their accompanying veins.

Fig. 165.

The anastomotic branch, the last-named branch of the (superficial) femoral, passes off near the opening in the adductor magnus; it gives a superficial offset with the saphenous nerve, and a deep articular one in front of the tendon of the adductor, which arches outwards across the front of the lower end of the femur.

Operation.—(1.) The *common femoral* artery may be ligatured, by an incision over its course, between the inferior margin of Poupart's ligament and the origin of the deep femoral—about one to two inches below. (Fig. 165.) But the results of this operation have been most unsuccessful, owing to the shortness of the trunk in this situation, and consequent freedom of the collateral circulation.

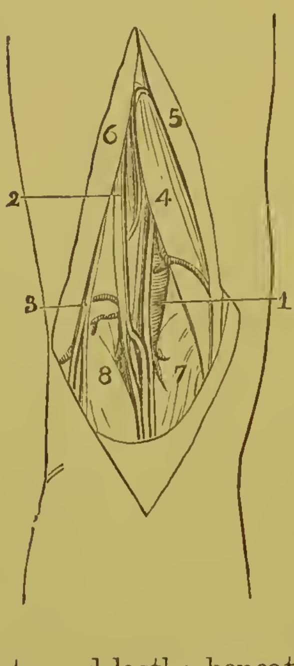
(2.) The *superficial femoral* is easily reached as it passes out of Scarpa's triangle, under the inner border of the sartorius muscle. If

the limb be rotated outwards, a line drawn from midway between the symphysis pubis and the anterior superior spine of the ilium, downwards to the inner side of the patella, will about indicate the direction of the vessel. An incision, in this line, three or four inches long and passing over the sartorius, leads to the artery in some part of the incision where that muscle crosses the artery. (See Fig. 165.) If the outline of the sartorius be perceptible, as in a thin person, the inner border of the muscle will be the best guide; along which the incision may be made. Dividing the skin and superficial fascia, and avoiding any large branch of the saphena vein, the thin bluish-white fascia lata should then be cautiously divided or slit up on a director to the same extent. A branch of the internal cutaneous nerve may now be seen, and avoided, lying on the sheath of the vessels. The artery, with the vein inclining from the inner side behind it—to gain the outer side—are to be gently separated; and the needle introduced between them. Proper care must be taken to avoid wounding the vein or including it in the ligature; and the usual precaution observed of testing the aneurismal pulsation, by compression with the finger on the presumed artery, before tightening the ligature.

In *Hunter's canal*, the superficial femoral was originally ligatured by John Hunter for popliteal aneurism, in the operation which he introduced (see Fig. 165); but it is not practised now-a-days, on account of the difficulty of reaching the artery in this the deep part of its course, compared with the facility of applying a ligature in Scarpa's triangle.

Ligature of the Popliteal Artery.—*Surgical Anatomy.*—In continuation of the superficial femoral, the popliteal artery extends from the *opening* in the *adductor magnus*, over the back of the lower third of the femur and knee-joint, to the *lower border* of the *popliteus muscle;* where it bifurcates into the anterior and posterior tibial arteries. It thus passes through the popliteal space or ham. (Fig. 166.) In *direction*, this artery inclines from the inner side of the thigh—its lower third—to the middle of the knee-joint, posteriorly, and thence descends vertically to its termination. The *depth* of the vessel is greatest above the joint, and comparatively superficial over it, but deeper beneath the heads of the gastrocnemius muscle, to the lower border of the popliteus.

Fig. 166.*



The popliteal artery *lies* at first opposite to, but not in contact with, the lower third of the posterior surface of the femur, which curving forwards occasions the interval; then, the posterior ligament of the knee-joint; and lastly, beneath the gastrocnemius, on the popliteus muscle.

* Popliteal space.—1. Popliteal vessels. 2. Internal popliteal nerve. 3. External popliteal. 4. Semi-membranosus muscle. 5. Semi-tendinosus. 6. Biceps. 7 and 8. Heads of the gastrocnemius; short saphenous vein between, entering the popliteal vein. (Quain, "Arteries," reduced.)

The *lateral* relations of the artery are the muscles bounding the popliteal space. (See Fig. 166.)

This space is formed by an interval between the attachments of the muscles, behind the knee, to the condyles of the femur. The popliteal space is lozenge-shaped when the muscular boundaries are allowed to fall aside, by removal of the ensheathing fascia lata. The flexor or hamstring muscles of the thigh diverge over the lower third of the back of the femur to their insertion; namely, the biceps, externally to the head of the fibula; the semi-tendinosus and semi-membranosus muscles, internally, to the tibia, the sartorius and gracilis muscles also intervening between them and the femur; below, the fleshy heads of the gastrocnemius converge from their origin above the outer and inner condyles of the femur, and unite just below the joint,—but above the lower border of the popliteus muscle. The plantaris muscle also, arising from the line above the outer condyle under cover of the gastrocnemius, forms an additional lateral boundary to the popliteal space, externally.

The popliteal artery extends through the popliteal space, and a little way lower down than its inferior boundary—the united heads of the gastrocnemius, for the artery terminates at the lower border of the popliteus muscle.

A small branch of the obturator nerve, from the plexus in the middle of the thigh, descends upon the femoral artery, and into the popliteal space, on the popliteal artery.

The *popliteal vein* and *internal popliteal nerve*—one of the divisions of the great sciatic—accompany the artery through this space, and beyond it; having the same extent as that vessel, or to the lower border of the popliteus. The vein is superficial to, and in contact with, the artery. Above the joint, it lies somewhat to the outer side of the artery; over the joint, it overlays and conceals the artery between the heads of the gastrocnemius; and under that muscle, it inclines across the artery lying to its inner side at the lower border of popliteus. The nerve, superficial to the vein, has the same relations to it, and thence to the artery beneath the vein. Thus above, the nerve lies to the outer side of the vein; over the joint, on the vein between the heads of the gastrocnemius; and under that muscle, it crosses the vein—and artery beneath—lying to its inner side at the lower border of the popliteus. The *external* popliteal nerve—the other division of the great sciatic—descends obliquely outwards along the outer side of the space close to the biceps muscle, to just below the head of the fibula; having, therefore, no relation to the artery.

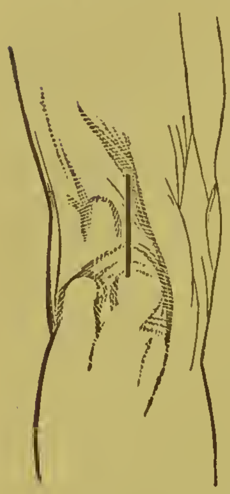
Overlapped above by the muscles, bounding the space, especially by the semi-membranosus, the popliteal artery is thus concealed, as well as partly by the vein and nerve, and also by a quantity of fat, in which are embedded a few small lymphatic glands around the artery; over the joint, the artery—with the vein and nerve—is *covered* only by the skin, superficial fascia, and fascia lata; but below the joint, by the gastrocnemius also, beneath which the small fleshy belly of the plantaris muscle crosses inwards over the popliteal vessels and nerve. The fascia lata, ensheathing the limb, holds the muscles together, and conceals the popliteal space; the line of separation between the muscles bounding the space, being indicated only by a slight vertical depression on the fascia lata, in the middle line. The *small sciatic nerve* descend-

ing along the back of the thigh, beneath the fascia, nearly corresponds with this depression; and a little below the knee it perforates the fascia to become subcutaneous. The external or *short saphenous nerve*, a branch of the internal popliteal, descends, beneath the fascia, between the heads of the gastrocnemius to the middle of the leg; perforating the fascia, it is joined by a communicating branch from the external popliteal, and accompanies the external saphenous vein. The external or *short saphenous vein* coursing up the back of the leg, in the superficial fascia, passes between the heads of the gastrocnemius, and perforates the fascia there, or lower down, to enter the popliteal vein. It thus lies over the course of the short saphenous nerve, separated by the fascia lata.

The *Branches* of the popliteal artery are not of much importance, surgically. Supplying the muscle, and the joint, the latter branches are the superior articular—inner and outer; the inferior articular—inner and outer; and the azygos, which enters the back of the joint through the posterior ligament.

Operation.—The popliteal artery is reached by a vertical incision, in the middle line, from about three inches above the centre of the popliteal space and carried down to the extent of four inches. (Fig. 167.) Dividing the skin, superficial fascia, and fascia lata, the tendon of the semi-tendinosus is exposed internally, and the incision continued cautiously along its outer border. The internal popliteal nerve and the popliteal vein are seen, particularly the latter, lying superficial to, and somewhat to the outer side of the artery. Slightly flexing the joint, the semi-tendinosus and semi-membranosus muscles are drawn inwards with a curved retractor; the vein being gently separated from the artery, it is protected in like manner externally, thus bringing the vessel more clearly into view; and the aneurism-needle should then be passed from without inwards, between the vessels.

Fig. 167.



Ligature of the Anterior Tibial Artery.—*Surgical Anatomy.*—The anterior tibial artery extends from the *bifurcation* of the popliteal, at the lower border of the popliteus muscle, to the front of the *ankle-joint;* thence to the posterior part of the first interosseous space, it is named the *dorsal artery* of the *foot. Directed*, at first forwards, through the aperture above the interosseous membrane, the anterior tibial passes downwards and forwards to the foot. (Fig. 168.) Situated externally to the shaft of the tibia, in the upper two-thirds of its extent, the artery inclines in front of the tibia, in the lower third.

Deeply placed above, between the muscles, in the upper two-thirds of its course, it becomes superficial below, between their tendons, and in front of the tibia and ankle-joint.

The anterior tibial artery *rests* on the interosseous membrane, and then on front of the tibia and ankle-joint. It lies *between* the muscles above; first, between the tibialis anticus internally, and the extensor longus digitorum externally, in the upper third of its course; and then between the same muscle internally, and the extensor proprius pollicis externally; but beneath the anterior annular ligament, the tendon of

the latter muscle crosses over the vessel to the inner side. The *venæ comites* surround the artery with cross branches, particularly above. The *anterior tibial nerve*—a division of the external popliteal—winds round from below the head of the fibula between it and the peroneus longus muscle, then inwards beneath the extensor longus digitorum, and, between the tibialis anticus and extensor longus, it inclines downwards to the artery about the middle of the leg; crossing the vessel once or twice in its course, the nerve is still external at the ankle-joint.

Fig. 168.*

Overlapped laterally by the fleshy bellies of the three muscles between which it lies, the artery is *covered* only by the skin, superficial fascia, and aponeurotic fascia; but beneath the anterior annular ligament, it is crossed by the tendon of the extensor pollicis from without inwards. The aponeurotic fascia is attached to the crest or spine of the tibia and to the outer margin of the shaft of the fibula; thus binding down the muscles in their relative position. Intermuscular septa, indicated by white vertical lines, pass in between the muscles, dividing them into three groups: an anterior extensor group of three, between the shafts of the tibia and fibula; an external or peroneal division of two, on the outer surface of the fibula; and the flexor muscles, on the back of the leg. The extensor muscles are separated by an intermuscular septum between the tibialis anticus and extensor longus digitorum. This septum can be readily recognized through the integuments when the foot is extended, the fleshy bellies of the muscles above rising up, and thus indicating the line of the septum. The anterior annular ligament of the ankle, a thickened portion of the aponeurotic fascia, consists of an upper and lower portion; in the latter there are three sheaths for the tendons of the extensor muscles—an inner one for the tibialis anticus, an outer for the extensor longus digitorum, and a middle intermediate sheath for the extensor pollicis. The artery behind the latter tendon is separated from it by the sheath.

The *branches* of the anterior tibial artery are muscular offsets and named branches: the recurrent, ascending in the tibialis anticus to the

* Anterior Tibial Artery.—1. Tibialis anticus muscle. 2. Extensor pollicis and extensor longus digitorum muscles drawn outwards. 3. Part of the anterior annular ligament. 4. Anterior tibial artery; anterior tibial nerve external. (Quain, "Arteries," reduced.)

knee-joint; and malleolar, internal and external, which pass horizontally over the ends of the tibia and fibula.

The *dorsal* artery of the foot, continuing the anterior tibial from the front of the ankle-joint to the posterior part of the first interosseous space, sinks into the sole of the foot to communicate with and complete the plantar arch. In its course, the artery *rests* on the astragalus, scaphoid, and internal cuneiform bones; it lies *between* the tendon of the extensor pollicis internally, and the inner tendon of the extensor brevis digitorum externally, as far as about half an inch before the artery sinks into the sole, where this tendon crosses obliquely over to the inner side; the vessel is *covered*, otherwise, only by the skin, superficial and aponeurotic fascia, here a very thin membrane. Two *venæ comites* accompany the vessel, also the anterior tibial nerve, which still lies external; becoming cutaneous in the first interosseous space, to supply the opposed sides of the great toe and the next.

The *branches* are—a tarsal branch, which arises opposite the scaphoid bone, and passes under the extensor brevis to the outside of the foot; and a metatarsal branch, which forms an arch across the foot, under the extensor, near the bases of the metatarsal bones.

Operation.—The intermuscular septum is the best guide to the anterior tibial, between the fleshy bellies of the tibialis anticus and extensor communis, and continued down between the former muscle and the extensor pollicis. Or, a line drawn from the inner side of the head of the fibula to the centre of the ankle, will indicate the vessel, throughout its course.

Fig. 169.

In the *upper third* of the leg, an incision from two to three inches in length, between the extensor communis and tibialis (Fig. 169), leads down to the artery, deeply placed under cover of the latter muscle. The anterior tibial nerve, distant to the outer side, is here out of the way. On drawing the tibialis muscle inward, the artery is seen with its venæ comites, and the ligature may be passed from either side of the vessel.

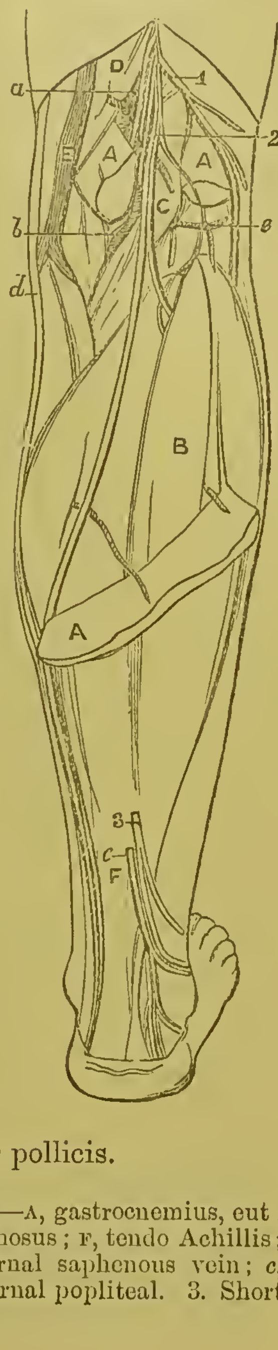
In the *lower two-thirds* of the leg, an incision, less in length and depth, will find the artery between the less fleshy portions, or between the tendons, of the extensor pollicis and tibialis anticus (see Fig. 169); but in the lower third, the artery inclines in front of the tibia, with the tendon of the former muscle approaching to cross over it. The anterior tibial nerve, from about the middle of the leg, may be seen accompanying the artery and its venæ comites. Drawing the tendons aside, with the nerve, the vessel is easily ligatured from either side.

The *dorsal artery* of the foot can be readily reached by an incision along the outer side of the tendon of the extensor pollicis (see Fig. 169), dividing only the skin, superficial fascia, and aponeurosis. The artery is seen between this tendon and the inner tendon of the

extensor brevis digitorum, externally, or which may pass over it to the great toe.

Ligature of the Posterior Tibial Artery.—*Surgical Anatomy.*— Continuing the popliteal artery from its *bifurcation* at the lower border of the popliteus muscle, the posterior tibial thence extends to the lower border of the *internal annular ligament;* there terminating in two plantar arteries for the sole of the foot. Its *direction*, at first, is vertical midway between the tibia and fibula, but inclining inwards it descends over the lower end of the tibia, posteriorly, and then in the middle of the hollow between the inner ankle and heel. Very *deeply* placed above, under the muscles of the calf, it becomes more superficial, behind the tibia and inner malleolus.

Fig. 170.*



The posterior tibial artery *lies* at first on the tibialis posticus muscle, but passing inwards, on the flexor longus digitorum and lower end of the tibia and ankle-joint. In the upper half of its course, the artery lies *between* the tibialis posticus and the fleshy bellies of the gastrocnemius and soleus muscles, which conceal it; in the lower half, it lies between the tendo Achillis and inner margin of the tibia. (Fig. 170.) Behind the inner malleolus, the tendon of the flexor longus pollicis is external, and the tendons of the tibialis and flexor longus digitorum are between the artery and the malleolus. Two *venæ comites* surround the artery with cross communicating branches. The *posterior tibial nerve* (Fig. 171), a continuation of the internal popliteal at the lower border of the popliteus muscle, lies internal to the artery for about one inch and a half; but crossing to its outer side, it continues to have that relative position down the leg to the interval between the malleolus and heel, there lying immediately to the outer side of the vessel, between it and the tendon of the flexor pollicis.

Covered by the gastrocnemius and soleus muscles, as far as the middle of the leg (Fig. 170), the artery below is covered only by the skin, superficial and aponeurotic fascia. The annular ligament—a thickened band of the aponeurosis—stretches across between the inner malleolus and os calcis. It sends inwards three sheaths for the tendons of the flexor muscles; an inner one for the tibialis posticus, behind which is another for the flexor longus, and externally, near the os calcis, is a third for the flexor pollicis.

* Muscles of the calf of the Leg; Vessels and Nerves.—A, gastrocnemius, cut; B, soleus; C, plantaris; D, semi-membranosus; E, semi-tendinosus; F, tendo Achillis; *a*, popliteal artery; *b* and *e*, articular branches; *d*, internal saphenous vein; *c*, external saphenous. 1. External popliteal nerve. 2. Internal popliteal. 3. Short saphenous, cut. (Ellis, "Illustrations of Dissections.")

Branches.—The *peroneal*, almost equal in size to the posterior tibial, arises about one inch and a half below the border of the popliteus muscle, where the posterior tibial nerve crosses the artery to the outer side; passing onwards between the muscles to the fibula, it descends somewhat under cover of that bone and in the fibres of the flexor pollicis, to the aperture below the interosseous membrane; there sending a branch forwards, and another between the tibia and fibula to the outer side of the foot. Other branches of the posterior tibial are of smaller size; some are muscular in the course of the artery, and an anastomotic communicating branch passes outwards across the lower end of the tibia.

Fig. 171.*

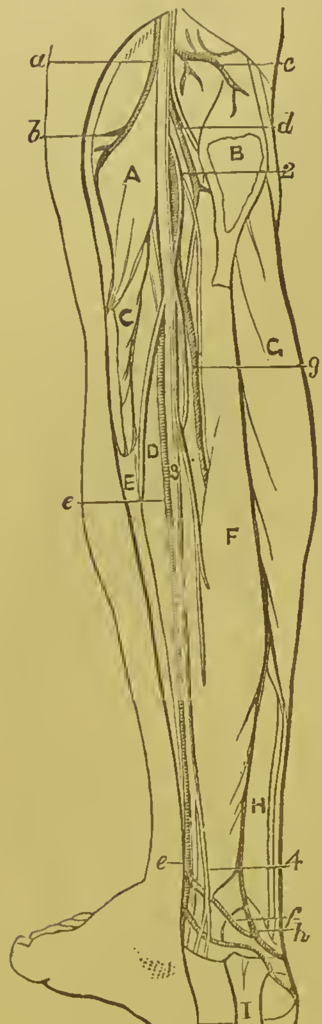


Fig. 172.

Operation.—*High up*, under cover of the gastrocnemius and soleus muscles, the posterior tibial may be reached by a free incision between the margin of the tibia and the gastrocnemius. (Fig. 172.) This incision must be continued down to the tibial origin of the soleus, which is then to be divided; both these muscles are drawn back, aided by flexure of the leg and extension of the foot to relax the muscles; the artery with its venæ comites will thus be found, and the nerve to

* Posterior Tibial Artery.—A, popliteus muscle; B, outer portion of soleus, cut; C, inner portion, cut; D, tibialis posticus; E, flexor digitorum; F, flexor pollicis; G, peroneus longus; H, peroneus brevis; I, tendo Achillis; *a*, popliteal artery; *b* and *c*, articular branches; *d*, anterior tibial artery; *e*, posterior tibial artery, and *f*, its communicating branch to the peroneal artery; *g*, peroneal; *h*, continuation of the peroneal to the outside of the foot. 1. Internal popliteal nerve. 2. Muscular branch of posterior tibial. 3. Posterior tibial nerve. 4. Cutaneous plantar. (Ellis, "Illustrations of Dissections.")

the outer side or crossing to that position. The introduction of an aneurism-needle and securing the ligature may prove very difficult, owing to the depth of the vessel. This operation was condemned by Mr. Guthrie, as "difficult, tedious, bloody, and dangerous;" and he proposed a substitute, which was practised by Mr. Arnott in a case where he ligatured the posterior tibial artery for a *wound* of that vessel, high up.

Having applied a tourniquet to the femoral or poplitcal, an incision, six or seven inches long, is made down the middle of the calf of the leg, over the skin-wound, as nearly as possible, or leading down to the artery at its wounded point. The gastrocnemius and soleus muscles must be divided freely, their opposed surfaces being recognized successively as tendinous expansions; the under surface of the soleus having been reached, the muscles are held aside with curved retractors, and a thin bluish-white aponeurotic septum, between the muscles of the calf and the tibialis posticus, comes into view. Immediately beneath this septum the posterior tibial vessels and nerve will be found, lying on that muscle. But, as in the arm, the horizontal process of the aponeurotic fascia which thus separates the superficial and deep layer of muscles, is commonly very indistinct and indeed merely cellular in the upper part of the leg.

Scraping away this thin membrane, the artery is ligatured above and below the wounded point, including, probably, the venæ comites and some surrounding muscular tissue.

Low down, behind the inner malleolus, the artery can be readily secured by an incision midway between the malleolus and the tendo Achillis. (See Fig. 172.) Dividing only the skin, superficial fascia, and aponeurosis, the artery is found with the nerve to its outer side. By extending the foot, and turning it slightly inwards, to relax the flexor and tibial muscles, the ligature can be at once passed and tied.

The *peroneal* artery may be reached by an incision along the outer border of the fibula, between it and the gastrocnemius. The flexor longus pollicis must then be either partly divided or drawn outwards, when the artery will be found in the fibres of that muscle and running close under the fibula. The ligature must be passed as best the Surgeon may be able. This operation, like that on the posterior tibial higher up, is more easily described than done.

CHAPTER XXVIII.

DISEASES OF ARTERIES.

Arteritis.—*Structural Conditions.*—Inflammation of any portion of the arterial system produces structural alterations in the coats of the vessel, similar to those resulting from inflammation of any other texture. Increased vascularity, and interstitial exudation of fibrinous matter, renders the coats of a bright red colour, thickened and pulpy; the

interior of the artery, in particular, has a crimson hue, as though some irritating fluid had been injected into the vessel, and it is lined with a slight lamella of lymph here and there, whereby the coats becoming fused, the vessel loses its elasticity. The blood within the vessel coagulates and forms a plug, which more or less completely blocks up the vessel, thus rendering it impervious as a blood-conveying tube, and below which the calibre of the artery is somewhat contracted. This plug, conical in shape, consists partly of a yellowish fibrinous exudation, occupying its base and adhering to the interior of the vessel, and partly of ordinary black coagulum, which forms apparently on this inflammatory portion, and, tailing off to some distance, is not adherent to the vessel. This condition is denominated *Adhesive* Arteritis. Inflammation, with the apparent secretion of pus, instead of fibrine, from the interior of the vessel, may perhaps occur sometimes, and it is probably of a spreading character; but whether this puriform matter be true pus, or disintegrated fibrine, remains, I think, to be determined by further observation. This condition constitutes the *Suppurative* and *Diffuse* Arteritis of some authors.

The *Symptoms* of Arteritis are referable both to the vessel affected, and to the part which it supplies with blood. Induration, and a cord-like feeling of the vessel when passed under the finger, arises from the thickening of its coats, and coagulation within the tube. Pain of a twofold character is experienced; a superficial sensitiveness of the skin over the artery, and a deep burning or lancinating pain in the course of the vessel, and striking through the limb. But any redness or heat in the inflamed part will scarcely be perceptible. The pulsation is peculiarly thrilling or jerking, but it diminishes gradually, and at length ceases. Below the part supplied by the vessel, the temperature declines, accompanied with a sensation of weight and fulness, and a loss of voluntary power. Gangrene is imminent. The *general* symptoms are those of inflammatory fever, speedily subsiding into prostration.

Causes.—Arising usually from some form of injury—a blow, a strain, a wound, or the application of a ligature—arteritis may also proceed from some constitutional condition of obscure nature. Some blood-condition, probably, representing what is termed a broken constitution, seems to be the cause of the diffuse form of arteritis. The traumatic and constitutional modes of origin may co-operate.

Course and Terminations.—(1.) Absorption of the coagulum may take place, the artery regain its natural calibre, and the circulation be fully restored. (2.) Or the coagulum remaining and extending, gangrene, in the dry form of mortification, supervenes, the artery becoming contracted and obliterated as a fibro-cellular cord. Gangrene may be prognosticated, in proportion to the degree of occlusion, its suddenness, and the size of the arterial trunk. Absorption, or rather, transmission of the fibrinous exudation in a state of disintegration, or of pus if secreted, would seem to occur in some cases, and give rise to the symptoms of *Pyæmia.* This event is, perhaps, more especially incident to diffuse arteritis.

Treatment.—Local blood-letting, by means of leeches applied in the course of the vessel, and warm fomentations should be followed by calomel and opium, to prevent fibrinous exudation, and alkaline salines to promote disintegrative solution of the coagulum. But certain measures, remedial in relation to inflammation or its consequences in

other textures, are here inappropriate; the arterial system, in part at least of its extent, being itself the seat of inflammation. Thus, stimulants, in their beneficial influence on the general circulation, might increase the exudation of fibrinous matter within the vessel inflamed, and induce gangrene. Stimulating applications also, as mercurial inunction, to promote absorption of the exudation would be similarly hazardous.

The treatment of gangrene, medicinally, and with reference to amputation, and also of any pyæmic symptoms, presents nothing peculiar.

Degenerations of Arteries.—In the course of life, the arterial system, more especially, undergoes certain degenerations of structure, which, apart from their intrinsic pathological interest, have great practical importance; both with regard to the diseases of organs and textures generally, and with reference to the consequences of such changes in the vessels themselves. But these degenerations of arterial texture relate primarily, and almost entirely, to the inner and middle coats of the vessels, the external or cellular coat remaining unaffected, or even passing through changes of an opposite character; this difference being due to the vascularity, and therefore higher nutrition, of the external coat. Degeneration leads to destruction of the inner and middle coats of an artery; hyper-nutrition of the external coat supplies a compensatory, albeit at length ineffectual, provision for the preservation of the continuity of the vessel.

The degenerations to which arteries are subject are of three kinds: *cartilaginous*, *atheromatous*, and *ossification*. These deteriorative alterations of structure differ in, at least, five important particulars: the kind of matter deposited; its seat, with regard to the arterial coats; and the appearances presented; the changes which take place in the deposit, and in the arterial coats, with corresponding alterations of appearance; the vessels which are principally affected in the arterial system.

(1.) *Cartilaginous degeneration.*—Cartilaginous patches are apt to form on the free surface of the inner or membranous coat, lining the arteries; partly in the aorta and large vessels, especially at the offset of branches, but principally in the smaller arteries, where these patches are more frequent and numerous. Commencing in the form of a substance having a semi-fluid or gelatinous consistence, and a pale yellow or reddish colour, this exudation from the membrane, or perhaps deposit from the blood-stream, appears as a layer of greater or less extent, upon the inner surface of the artery. With any such gelatinous layer may be associated other deposits, in which the substance is more consistent, white and opaque, like boiled white of egg; and others, again, which present the appearance of cartilaginous patches. There seems, then, to be a gradual transition from the former to the latter or more complete condition of this degeneration. The lining membrane of the artery becomes so adherent to, or identified with, these patches, that they may be said to lie in contact with the middle coat. Certain changes may take place in connection with the cartilaginous plates. When several such plates are grouped together, they become overlaid with a thin, pellucid membrane, as if a layer of the inner membranous coat was continued over them. The walls of the artery are thickened, and less elastic; and the inner surface of the

vessel, retaining its polished appearance, is finely puckered. Occasionally, a cartilaginous plate may become partly detached, and thus approach to the formation of a breach of surface—an ulcer; while the projecting eminence within the artery offers a nucleus for the gathering around of fibrinous deposit from the retarded blood-stream. But the cartilaginous patches are never subject to any intrinsic change, by softening or ossification. Such, at least, is the result of Hasse's observations; Audral and other pathologists have recognized the change of ossific transformation.

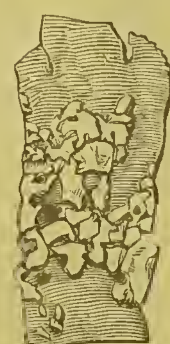
Atheromatous, or Fatty Degeneration.—Atheromatous matter is originally seated between the internal and middle coats of the artery affected, or partly between the muscular fibres of the latter tunic; appearing in the form of patches, of a yellowish-white colour, and opaque, flattened or slightly elevated, and fairly defined in outline; thus presenting a different aspect from the inner surface of the artery in other portions of its extent. Even so abundant may be the atheromatous substance as to form lumpy protuberances within the artery. The aorta and large-sized arteries are mostly subject to this kind of degeneration. As age advances from mid-life, or earlier, some such atheromatous patches may be found after death from any cause. The atheromatous matter consists of fat-particles, with scales of cholesterine and amorphous granules; having a variable consistence, from that of firm putty to pultaceous or puriform matter. This fatty deposit, or educt of degeneration, is very liable to either of two changes of opposite character: softening and liquefaction, or hardening into an ossific deposit. Disintegration of the middle and internal coats of the artery accompany either of these two transformations.

Softening of the atheromatous matter is attended with disintegration of the middle coat of the artery, which gradually loses its fibrous texture, becoming friable, and of a yellowish colour; then, the inner membrane of the vessel disintegrates, cracks, and at last disappears, forming an *ulcer*, corresponding to the former atheromatous patch. The ulcer which results from these destructive changes is set in the artery, its base being the external cellular coat, with any remains of the middle tunic; it has thus an uneven surface, while the edges are flattened and ragged. The softened atheromatous substance having escaped, and been washed away by the blood-stream, the artery, attenuated at the spot of ulceration, is exposed to the force of the current, beating on the bare external coat. Aneurismal dilatation would invariably ensue, or perforation of the artery, with sudden, and perhaps fatal, internal hæmorrhage. But the external coat, always vascular, acquires even greater vascularity, and becomes thicker and stronger, offering a more resisting support, as the atheromatous degeneration pursues its destructive course. The other two coats do not share in this compensatory adjustment to the impinging force of the blood-current. No vascular development, in these membranes, besets the ulcer; its margins and base acquire a deep grey or blackish colour; while around the circumference, small fibrinous clots are gathered from the blood, and disposed sometimes in stratified layers, accumulating yet more and more. Rarely, an atheromatous ulcer heals; the inner surface of the artery is then marked with a black depression, in a puckered cicatrix; leaving the artery, however, weak at that spot. Ulceration occurs more commonly in the aorta,

particularly in its abdominal portion; rarely in the second and third sized arteries.

Ossification or Calcareous Degeneration.—Calcification, Cretification.—This kind of degeneration may be consequent on the atheromatous, or it may occur independently. (*a.*) As a sequel of atheromatous degeneration, ossific transformation of the arterial texture, consists of thin scales, having a brittle consistence and pale yellow colour. They are seated between the inner and middle coats of the artery; and lying immediately beneath the inner membrane, these scales look what, indeed, they are—ossified atheromatous patches, and can be readily felt in the walls of the vessel, between the thumb and finger, giving a thickness and rigidity to the substance of the artery. In this form the degeneration is sometimes named *laminar* ossification. (Fig. 173.) But the deposit is not truly ossific, in the sense of having the structure of bone; that would imply a development, and to a high degree of structural formation, quite opposed to the nature of structural degeneration. The quasi-ossific deposit consists—as Valentine and others have shown—of earthy particles, having a round, annular, or irregular shape, with radiating prolongations; this earthy or cretaceous matter being set within a pellucid, somewhat laminated, and finely granular organic texture. The scales, thus constituted, thicken and extend, with disintegration and disappearance of the fibres of the middle coat; while the inner membrane, adherent to the scale, cracks at the centre, and perhaps, at last, wastes away, thus approaching to the state of atheromatous ulceration within the artery. The bony scale becomes loosened, and partly detached from the remnant middle coat; in this state, or perhaps enlarged to a rough eminence, it may project within the vessel, more or less obstructing the canal, and gathering fibrinous coagula from the impeded blood-current. In this way an artery becomes partly *occluded*, as well as *contracted* or narrowed by increasing thickness of the adjoining parietal deposit; forming a more or less rigid and inelastic tube. Thence, probably, the origin of a general or circumferential *dilatation* of an artery, under the constantly expansive force of the blood-stroke; as in the aortic arch. But at any spot weakened by an upturned bony scale within the vessel, there the artery is liable to true *aneurismal dilatation* into a sac, or there spontaneous *rupture* may occur.

Fig. 173.*

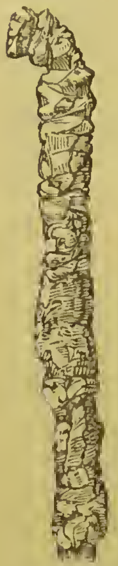


(*b.*) Ossification taking place independently of previous atheromatous deposit, differs in some particulars from that already described. This second form of the degeneration was clearly defined by the observations of Audral and Lobstein. The ossific or cretaceous matter, consisting of phosphate and carbonate of lime-granules, is still deposited betwixt the inner and middle coats of the artery, but invading the latter tunic, which has lost its fibrous texture, owing to disintegration and atrophy. The inner surface of the vessel, therefore, assumes a dotted and rough granular appearance; while the walls feel somewhat rigid and inelastic. Arteries of the second and third size are chiefly affected with this form of ossification. The changes which the deposit

* Middlesex Hosp. Mus.

passes through are also peculiar. The inner membrane of the artery rarely becomes involved. But the granular matter may be disposed in transverse streaks, at length forming complete rings around the interior of the vessel; sometimes named *annular* calcification. (Fig. 174.) Then the artery may acquire an alternately constricted and dilated condition; the enlargements corresponding to the intervals between the rings, and where the walls are thinned by the atrophic disintegration of the middle coat, without the support of the substituted ossific deposit. Sometimes, by coalescence of closely arranged adjoining rings, the artery becomes converted into a rigid, inelastic tube; as may also occur more often, from the conjunction of bony scales, in the other form of ossific degeneration; and this change of appearance has been named *tubular* calcification. Another, and very rare, form of the deposit is described by Bizot, in which the calcareous granules are disposed in linear direction upon the inner membrane of the artery; primarily, in elliptical groups, afterwards having the shape of irregular scales. They seem to originate in transverse cracks of the inner coat, which gather the cretaceous granules around their edges.

Fig. 174.



The *different kinds* of degeneration — the cartilaginous and the atheromatous—are not unfrequently found associated, and in the same artery; and with atheroma, or where softening is taking place in one patch, there may be ossification co-existing in another and neighbouring patch. Hence the varied appearances which an artery or the arterial system may exhibit, when examined in states of degeneration.

The *relative frequency* of degeneration, in its different forms, varies, however, in different arteries. This diversity has already been noticed. Commencing with the aorta, this parent trunk is the chosen scene of these deteriorative and destructive changes in the arterial system. Chiefly affecting the posterior surface of the aorta, and where branches are given off, degeneration extends downwards, through the thoracic and abdominal portions of the artery. Ossification, as affecting different arteries, proceeds in the following order of frequency, according to Lobstein's arrangement:—"Arch of the aorta, end of the common iliac artery, thoracic aorta, splenic artery, abdominal aorta, femoral artery and its branches, spermatic artery, hypogastric and its branches, coronary arteries of the heart, branches of the subclavian, bifurcation of the common carotid, the cerebral carotid, branches of the external carotid, arteries of the thoracic and abdominal walls, brachial artery and its branches, twigs of the umbilical, arteries of the substance of the brain, pulmonary artery." If this order of procedure be taken as an approximation to the truth, it will at least tend to correct the apparently arbitrary selection which is sometimes assigned with regard to different arteries, respecting their liability to ossific degeneration.

The *symmetrical distribution* of arterial degeneration, on both sides of the body, may be accepted as an almost invariable law, as shown by Bizot.

Causes.—The originating cause of degeneration, as affecting the arterial system, is obscure, and cannot be discussed here with much practical advantage. In whatever form degeneration may appear, it

is a manifestation of declining nutrition, with disintegration and atrophy of the natural texture-elements, and the substitution of a new material, of a lower organization, or perhaps merely inorganic; thus resulting in a transformation, which is incident to advancing life, or which may occur prematurely. Age, therefore, implies a natural predisposition to degeneration. This change becomes more frequent and extensive, and the various retrogressive transformations become more complete, in proportion to the age of the individual, from mid-life downwards. Yet, on either side of life's zenith, there are exceptions; premature ossification of the arteries having occurred in some rare cases at the early period of a year and three months, and at only 3, 8, 18, and 24 years; while, on the other hand, in quite old age, some persons are exempt from any arterial degeneration. Such exceptions, however, only verify the rule, and this—with regard to ossific degeneration of the arteries—is supported by the results of chemical analysis respecting the proportionate amount of earthy matter in healthy arteries, at successive periods of life. Thus, Gmelin found that the amount of earthy matter in the coats of the arteries progressively increases as life advances; that in a newly born infant, the ash of these vessels yields only 0·86 per cent. of phosphate of lime; in the adult, 1·25; in an old man, 2·77; and in an aged man, 4·01 per cent. of earthy matter. But constitutional predisposition is evinced by the marked tendency to arterial degeneration in persons under the influence of certain blood-poisons or diseases; notably, in connection with albuminuria from chronic kidney-disease, in chronic rheumatism and gout, in constitutional syphilis, and in phthisis. How the morbid blood-conditions in these diseases impair nutrition is doubtful; perhaps sometimes by inducing an inflammatory process, the products of which may pass into the retrograde states of atheromatous and cretaceous matter. *Sex* does not seem to have any special influence on arterial degeneration; males and females, of the same age, being about equally often affected; or women somewhat less frequently, and at a later period of life. But, in the two sexes, different arteries are more especially liable to degeneration; according to Bizot, the arteries of the upper limbs, in women; those of the lower limbs, and the coronary arteries of the heart, in men.

Consequences.—Arteries which have structurally retrograded into the various states of cartilaginous, atheromatous, and ossific transformation, have thus more or less lost their elasticity and resiliency, whereby the blood-streams through such vessels are misdirected; or the vessels being converted perhaps into rigid tubes, they are unfitted to transmit a varying quantity of blood; or having become narrowed, and partially occluded, they transmit less blood than may be required. Consequently, in the *organs* or parts depending on a due supply of blood for their nutrition and functions, degeneration of their arteries is not only attended with various functional disturbances, but structural alterations or diseases of the organs ensue, in various forms of malnutrition, and which have fatal tendencies or terminations. The principal effects and consequences of arterial degeneration are as follows:—Symptoms of *defective* or *deficient circulation*, as manifested by coldness in the extremities, spasmodic and neuralgic affections; *atrophy* and degeneration of organs, as of the heart, when the coronary arteries are diseased, causing angina pectoris and sudden death;

softening, as of the brain, when the cerebral arteries are affected; *hæmorrhage*, from rupture of a degenerated vessel; secondary hæmorrhage, after ligature; *aneurism*, from partial rupture, or dilatation, from general expansion of the artery; *gangrene*, as in the leg, from contraction and partial occlusion of the main arteries in the limb.

Ossification of Arteries and Senile Gangrene.—Ossification or calcareous degeneration of the coats of arteries—relating to the principal arteries of the leg—was noticed by Thomson and Hodgson, in connection with the dry form of mortification or mummification of the toes and feet; and which being incident to old age, is known as Senile Gangrene. Sir B. Brodie more particularly investigated the pathology of this disease, and according to his observations the structural changes are summarily these:—In the leg, calcareous degeneration of the larger arteries, and fibrous thickening of the smaller ones, are accompanied with a more or less inelastic and contracted state of the vessels, and perhaps the coagulation of fibrine within them; conditions which, together, produce a partial or complete obliteration of the channels through which arterial blood should be supplied.

Symptoms.—In either or both *legs*, numbness, coldness, and weakness are experienced from a defective supply of arterial blood; these symptoms come and go, being present whenever circumstances demand a more active circulation, which the unyielding arteries cannot allow; absent when a sluggish circulation is sufficient. Thus, rest, posture, and warmth may maintain this sufficiency; while active exercise, and any posture or pressure that further impedes the circulation, is soon attended with a sense of weakness in the limb, numbness, and coldness. Flying pains in the limb, or fixed pain in a spot, are sometimes experienced. Under these functional symptoms, as affecting one or both legs, gangrene is always more or less imminent.

Senile Gangrene.—Commencing, generally, on the pulpy portion of one or more of the toes, a port-wine red colour or a black discolouration appears, preceded by inflammation, or by a stinging sensation, or by numbness and coldness, as *premonitory* symptoms; but frequently without any such precursory local symptom. Soon a vesicle arises over this discoloured spot, or more than one vesicle. The vesicle or vesicles burst, disclosing the true skin in the blackened state of sphacelus. It is encircled with a dusky red hue. This death-warrant advances, perhaps slowly, extends over the toes and back of the foot, uniformly and symmetrically, followed up by the black shade of sphacelus. The accompanying pain is usually severe, though intermittent. Spreading up to the instep, senile gangrene presents the appearance as if the foot were thrust into a black slipper trodden down towards the heel. The dead part is black, shrunken, and mummified—the very type of *dry* gangrene. If both feet be effected, a pair of black hoofs is presented. (See Fig. 77.) It spreads to a variable extent; gaining the ankle, life usually succumbs to the consequent constitutional depression; occasionally, it may extend as high as the knee, or even to the thigh. But the limitation cannot be predicated, the causative condition of the arteries being undeterminable in its extent. Nature alone decides the "line of demarcation" betwixt the living and dying parts. The accompanying constitutional disturbance or fever is of the typhoid type. Rarely, senile gangrene may occur in the fingers, a case having been seen by Billroth.

Causes.—The inelastic, and contracted or obliterated state of the arteries, is frequently a *predisposing* condition only, although maintaining the gangrene when established. Some slight injury to the foot—an abrasion, scratch, or wound—is commonly the *immediate* cause, the gangrene being so far *traumatic.* Sir B. Brodie offers a reasonable explanation. During inflammation, an increased supply of arterial blood is required, and the arterial trunks leading to the inflamed part become dilated so as to permit this extra quantity; but, when these vessels are ossified, they lose their dilatability and power of accommodation, the greater supply of blood demanded by inflammation is withheld, and the part perishes. *Age* is certainly a predisposing cause, in virtue of the degenerative changes which the arteries, in common with other textures and organs, undergo as life advances. Hence, ossific degeneration of the arteries is liable to occur in persons past the middle period of life, say fifty years of age; those who are old in years, or in those who are prematurely old for their years. Either sex is liable to this degenerative change, though perhaps not equally so.

The *duration* of senile gangrene is uncertain. It may continue for a few weeks or months, even a year, and terminate fatally. Or, if limited to a toe or two, the part may be detached naturally, by the formation of a line of demarcation and ulcerative severation, or be removed surgically; and in either case the patient recover.

Treatment.—*Preventive* measures—in those who have had, from time to time, premonitory symptoms—will consist in the avoidance of the circumstances which, disturbing the circulation, are the immediate causes of senile gangrene. Hence, attention to rest, posture, and uniform warmth of the legs by clothing must always be primarily important; for this gangrene commences usually after a walk, long standing, or exposure to cold. Then again, the Surgeon should avoid the slightest operation, even the laying open of a sinus on the foot, if the patient has been subject to premonitory symptoms. Sir B. Brodie relates a case in his early practice, where such an operation—trifling in itself—gave rise to inflammation, gangrene of the whole foot on the following day; and in two days more death ensued.

The treatment of senile *gangrene* is both local and constitutional. The *local* indication is this: to solicit the formation of a line of demarcation or limitation of the gangrene, and thus also restrict the extent to which it might otherwise have spread. Consequently, means must be taken to maintain the temperature of the foot or feet, in order to diffuse the local circulation and sustain the vitality of the part; a condition necessary for nature to declare the line of severation between the living and dead portions. Cotton wadding or carded wool, in the form of a padding, deeply enveloping the limb, answers most effectually. This appliance was originally used by Mr. Vance, of Greenwich Hospital. The casement may be lightly retained in a silk handkerchief, sewn up. It need not be reapplied for some days; the gangrenous part being previously covered with lint soaked in chlorinated, carbolic, or other antiseptic lotion; or an ointment, which is less apt to dry, may be used, consisting of resin ointment with creosote. *During* the process of separation, reparative closure of the vessels, by adhesive inflammation, should be promoted by poulticing or an epithem of spongio-piline soaked in warm water. When the soft textures are detached, the bones may be sawn through, and the otherwise natural amputation

aided by this amount of surgical interference. Any earlier or more actual amputation would occasion some hæmorrhage, or might excite inflammation, and thus perhaps start the gangrene afresh. The *ulcer* left by the part removed, is a simple or healthy, healing sore. Therefore, during granulation and cicatrization, water-dressing may suffice, or a slightly stimulant lotion, as balsam of Peru, pure or diluted, with an equal part of yolk of egg. Subsequently, the internal cause of gangrene—ossification of the arteries—still being persistent, exposure to cold must ever be avoided, and the circulation cherished by the patient wearing thick woollen socks and flannel drawers.

Constitutional treatment will depend on the stage of the disease. During the *typhoidal* fever consequent on gangrene, prior to closure of the vessels, supporting measures are indicated; an easily assimilated diet of principally animal food, with malt liquor, and wine or alcoholic stimulants. Bark, ammonia, and chlorate of potash should be regarded as accessory only, in the form of a medicinal tonic and stimulant; a judicious restriction, which Sir B. Brodie more particularly inculcated. Opium is peculiarly efficacious; the tincture being given in small but repeated doses, to the amount of two to four grains in the twenty-four hours, and increased as the system is brought under its influence. The value of opium in senile gangrene was, I believe, originally advocated by Pott, and it is confirmed by the experience of Dupuytren, and of most modern Surgeons. But the supervention of headache or any disturbance of the digestive organs would suggest its discontinuance; even then, the hypodermic injection of morphia offers an advantageous substitute for its internal administration. During the *inflammatory* fever which accompanies occlusion of the vessels, in the separation of the gangrenous part, or when such febrile commotion may be otherwise present, opium should still be adminstered, to suppress the nervous excitement, while it sustains adhesive inflammation, and the general circulation and strength be supported by moderate diet, with a mild tonic and stimulant plan of treatment. Topical measures to regulate the inflammation would probably provoke gangrene.

VEINS.

CHAPTER XXIX.

INJURIES.—VARICOSE VEINS.—PHLEBITIS.

WOUNDS OF VEINS.—See WOUNDS, Ch. XVI.

ANEURISMAL VARIX, AND VARICOSE ANEURISM.—See ANEURISM, Ch. XXV.

VARICOSE VEINS, OR VARIX.—*Structural Conditions and Diagnostic Characters.*—Varix signifies an enlarged, elongated, knotty, and tortu-

ous condition of the veins of a part; the knotty enlargements corresponding to the sinuses behind the valves in these vessels. Thickening or thinning of the coats of the veins, at different points, and destruction, wholly or partially, of the valves, accompany these more perceptible changes of size and outline.

Certain more *minute* changes in the coats and valves of varicose veins are thus described by Hasse; changes which constitute *different forms* of varix, and represent the order of their occurrence:—

"In persons affected with a morbid preponderance of the venous system, we first of all observe an undue prominence of the veins of the skin. These appear in *dense nets* of branches, remarkable for their diffuse distribution, and are generally turgid with blood, or liable to become so from the slightest mechanical or dynamical causes—like what, under ordinary circumstances, would be the effect of violent and prolonged muscular exertion. In this condition of the veins, their *coats* have not undergone any absolute change, being everywhere proportionate to the width of the calibre; the vessels are not more than usually tortuous, and cannot as yet be called morbidly altered.

"After a while, however, the veins become permanently *dilated*, and more distinctly prominent (Fig. 175), an occurrence more frequent in elderly than in young persons. This is brought about by a reinforcement of the fibrinous texture of their *external coat*, in the shape of an accession of conspicuous transverse fibres. Meanwhile the internal membrane remains unchanged in structure, merely displaying numerous lines or superficial furrows running lengthwise, and the vessel still maintains its natural course, not assuming a more sinuous, but rather a straighter direction. It does not collapse on section, but remains patent, and is distinguishable from the arteries by its colour, which is of the same pale red as the fibro-felt texture constituting the normal external membrane of a vein. The *valves* remain unaltered. In this condition the saphena is frequently found in old persons, so also are certain branches of the vesical plexus, while other branches manifest still further changes.

FIG. 175.*

"In the greater number of instances, however, the external membrane of the vein is not thickened, but, along with the other membrane, presents considerable *attenuation*, in proportion as the vein becomes more and more dilated. Conformably with their irregular disposition, the intermediate fibres give way unequally, allowing the internal membrane to jut out in *sac-like protrusions*, and to establish so many irregular, constricted, pear-shaped, and often in appearance, pediculated tumours. At the commencement of some of the smaller branches, the membrane thus forms pouch-like dilatations, or forces itself between the longitudinal fibres of the external membrane in lengthy protuberances, which exceed in circumference that of the vein in its natural state; or it may, perhaps, distend cylindrically and pretty equably for a considerable length the intermediate fibres before alluded

* Saphena vein; showing enlargement, and varicose state, as seen under the integument. Royal Coll. Surg. Mus., 1719A.

to. Meanwhile the *valves* become attenuated, and pulled asunder transversely, so as to be useless; in many instances they become partially or wholly obliterated, or are torn into shreds, or destroyed as far as their free border, which then runs across the diameter of the vessel like a filament or band, attached by the two extremities to the internal membrane. The veins now appear *elongated*, and their course very *tortuous*." (Fig. 175.) The *blood*, at first fluid, is liable to coagulation, occluding the channel of a varicose vein. A sensation of weight, fulness, and even pain, accompanies this double obstruction to the venous circulation—varicosity of, and coagulation within, the veins. But the symptoms referred to are not peculiar to this condition; and they are increased by exercise and the erect posture.

The veins most liable to become varicose are the subcutaneous and submucous. The internal saphena, and less so, the external saphena, are peculiarly liable; and form the varicose veins commonly seen. Less commonly affected are the veins of the arms, abdominal parietes, the chest, external jugular in the neck, and the superficial veins of the head. The lower hæmorrhoidal veins around the anus, and the lower portion of the rectal mucous membrane, are frequently varicose; forming hæmorrhoids or piles, external or internal. The spermatic veins, around the cord in the scrotum, are not unfrequently affected, when the disease is named varicocele. Sometimes the veins connected with the pudic vein, as in the scrotum, or the nymphæ. Of deep-seated veins, those most liable to become varicose are the prostatic veins, the internal jugular, and the vena azygos.

Causes.—Any occasion of pressure on a venous trunk, or any cardiac obstruction to the free return of venous blood, or want of propulsive power of the heart, will induce varix. The veins of the lower extremities are so commonly the seat of this condition, owing to their distance from the heart, and the influence of gravitation. Habitually excessive walking exercise, or a standing occupation, operate in like manner. Wearing a tight garter below the knee, and the enlargement of the uterus during pregnancy, well illustrate the production of varicose veins by pressure on the saphena or iliac veins. Disease of the liver and rectal constipation have a similar relation to hæmorrhoids. Certain *predisposing* causes may be noticed. The want of support by surrounding textures predisposes superficial veins to become varicose. It is said that some degenerative change in the coats of veins, as in the arteries, may also be a provocative condition. Age has certainly a notable influence; the disease being rare in early life and increasing as years advance. Sex seems to have some influence; for a varicose state of the veins is produced more frequently in women; probably, chiefly, in connection with the uterine conditions of pregnancy or the formation of a tumour. Disorders of menstruation have, apparently, some causative relation to venous varicosity in the lower limbs; the saphena veins becoming distended and painful at each period, or the seat of vicarious hæmorrhage. Of thirty-four cases of crural varicosity, taken in succession, Mr. Gay found the disease to be clearly associated with catamenial disorder in fourteen; and similar observations had been made by Frankenau and Briguet. Hereditary tendency appears to have a marked influence in some cases. Lastly, injuries, such as fractures, laceration, burns, are not unfrequently followed by obstruction of the neighbouring venous trunks,

either from direct pressure, or from thrombosis; resulting in a varicose state of the veins which span over the interspace within which the injury occurs. Thus, observes Mr. Gay, when the thigh is broken high up, the veins between the saphena below and the superficial pubic and epigastric veins become varicose; whilst, when the leg is broken, the dorsal veins become similarly affected.

Course and Terminations.—(1.) Inflammation of the vein is very apt to supervene, and by increasing the liability to coagulation within the vessel, lead to further consequences; persistent œdema of the subcellular tissue, and ulceration, forming the *varicose ulcer.* (2.) *Venous hæmorrhage* may ensue, sometimes of an alarming character, in the event of ulceration extending into the vein, or some large branch. Similar hæmorrhage may proceed from attenuation and bursting of a varicose vein.

Treatment.—The removal of any cause in operation, as any occasion of pressure or obstruction, will, of course, be the primary rule to be observed. But this may not be possible, and treatment of the varicose condition of the veins affected may therefore prove useless; the suppression of varicosity in one set of veins being followed by a corresponding enlargement of other veins, as a compensatory provision for the circulation.

Palliative measures consist in rest, elevation of the part, and moderately firm, even, and continued compression of the veins, by means of bandaging with an elastic roller. (Fig. 176.) This figure shows the mode of applying a roller-bandage to the leg. Commencing from the toes, each turn of the roller is made to *overlay* the preceding one, so that no intervals are left between the turns, through which the integument would become swollen; the turns are made with moderate, but *even* firmness, by a slight pull in completing each circle; and *cross-turns* are made as the roller is carried up the leg, in order to adapt the bandage evenly to the increasing circumference of the leg—this manipulation being effected over the tibia by just fixing the bandage with the thumb of the left hand, as the cross-turn *downwards* is made, in carrying the roller around the leg. Or an elastic stocking may be worn, as another mode of affording support to the enlarged and weakened veins. These appliances relate specially to varicose veins of the lower extremities; but a similar mode of treatment is applicable generally. The treatment of a *varicose ulcer*, which often co-exists with varicose veins of the leg, is described in connection with Ulcers.

Fig. 176.

Varicocele and Hæmorrhoids are specially noticed in connection with Diseases of the Scrotum and Rectum, respectively.

Radical or *Curative* Treatment consists in obliteration of the Vein or Veins, by various operative procedures. They are none of them more than occasionally successful, and some are hazardous rather than curative.

The *twisted suture* may be applied at intervals along the course of the vessel; with *subcutaneous section* of the portion of vein included between any two such sutures, placed about one inch apart. (Fig. 178.) The subcutaneous section is made with a fine narrow-bladed tenotomy knife—straight or curved, as may be convenient. (Fig. 177.) The point of the knife is entered under the vein, and carried to the opposite side to just beneath the skin; then, by drawing the blade outwards,

Fig. 177.

Fig. 178.

so that the point traverses a semicircle under the integument, as felt by the forefinger of the other hand, the vein is thus divided, its thickened structure cutting with a leathery resistance. This operation has already been described in the treatment of Varicose Ulcer. It is the most successful and least objectionable mode of obliterating varicose veins. In no case, but one, have I seen any untoward event—sloughing, phlebitis, or pyæmia; and in some cases the cure has been permanent. It is the only mode of obliteration which I have recourse to. The suture part of this proceeding originated, I believe, with Velpeau; the subcutaneous section additionally, is due to Mr. Lee.

Subcutaneous section of the vein, without placing a suture-barrier on either side of the divided portion to guard either aperture, is always perilous: owing to the risk of pyæmic infection consequent on any phlebitis which may thus be excited. *Excision* of a small portion of the vessel is equally hazardous, as attested by Sir B. Brodie.

Cauterization, to excite inflammation of the vein, may be affected by the application of caustic potash, or chloride of zinc, so as to produce eschars in the course of the vessel; the phlebitis advancing to adhesion, and stopping short of suppuration, within the vessel. But thence the risk of pyæmic infection. Yet this mode of inducing obliteration has been recommended by Mayo, Seutin, Bonnet, and other Surgeons; and is particularly advocated by Mr. Skey, within certain limitations. He recommends the application of Vienna paste; potash in the proportion of two parts with three of lime, and spirits of wine being added to form a paste. The eschars should not exceed the size of a split pea, and their number be regulated by the extent of the varicose vein. Thus produced and restricted, they are said to be free from danger.

Injection of a few drops of the perchloride of iron, and the influence of *galvanism* transmitted through needles introduced into the vein, are modes of obliteration so questionable as to their efficacy, or their safety, that they need only be mentioned.

Venous hæmorrhage occurring in the course of varicose veins, the bleeding may be arrested, temporarily, by digital compression, slight

pressure with the point of the finger being quite sufficient; and permanently arrested by a compress of lint, secured by a bandage, over the aperture in the vein, with elevation of the limb.

Phlebitis.—*Structural Conditions.*—Inflammation of any portion of the venous system produces structural alterations in the coats of the vessels similar to those resulting from inflammation of an artery. It is said to be *Adhesive* or *Suppurative*, but more commonly the latter; and both forms of Phlebitis are far more common than Arteritis.

The coats of an inflamed vein have a dark red colour, and have become thickened and pulpy, owing to an interstitial fibrinous exudation; the inner coat, in particular, presents this hue—partly due to the imbibition of colouring matter from the blood, and a lamella of lymph is adherent to the surface. The blood within the vessel has undergone coagulation, more or less perfectly, forming a hard or soft blackish coagulum, mingled with the fibrinous exudation. Thus far phlebitis is *adhesive.* But pus being readily secreted within the vessel, *suppurative* phlebitis may soon be established. If limited within the boundary of the coagulum and fibrinous exudation, above and below—the pus lying between the coats of the vessel and the coagulum, and between interrupted portions of the coagulum—this circumscribed form of suppuration has been named *limited* suppurative phlebitis. And, as the matter thus occluded or imprisoned cannot be transmitted into the general circulation, this condition is not productive of pyæmic infection. But if the plastic lymph-barriers within the vessel, above and below these collections of pus, give way, *diffuse* suppurative phlebitis ensues, and pyæmia will be inevitable. This interpretation of systemic infection may, however, perhaps be abandoned in favour of more recent views relative to the pathology of Pyæmia. *Diffuse* phlebitis signifies a spreading form of the disease, but as this character is probably never unaccompanied by suppuration, the distinction seems unnecessary.

The *Symptoms* of Phlebitis are referable both to the vessel or vessels affected, and to the circulation in the part below. An inflamed vein is hard, cord-like, and knotted under the finger, painful or tender on pressure; and a purplish redness, with some degree of heat, may be preceptible in the course of the vessel. If the vein be varicose—a pre-existing condition not uncommon—these symptoms will be even more marked, and those of varix are superadded. The supervention of *suppuration* is denoted, in the limited or circumscribed form, by the symptoms of abscess in exchange for those of purely adhesive phlebitis. One or more small fluctuating swellings appear in the course of the vein; instead of its previously uniformly hard, cord-like character, which thus becomes more knotty—hard here, and softened there. In the *diffuse* form of suppuration, the whole tract of the vessel softens down uniformly; fibrine, coagula, and pus commingling.

Obstruction to the venous circulation, from the fibrinous exudation and coagulation within the vessel, produces some œdema in the part below, or general swelling of a whole limb, if a large venous trunk be the seat of obstruction. In adhesive phlebitis this swelling will be *most* conspicuous. No blood passes through the femoral vein, for example, in this condition of phlegmasia dolens; an arrest of circulation which soon tells on all the tributary veins throughout the limb. Its cellular texture becoming gorged with serum, the whole limb is

swollen, tense, and hard; of a polished, pearly white colour, or mottled, cold and insensible—a marble limb, and much larger than its fellow. The *general* symptoms are those of inflammatory fever, very shortly subsiding into prostration; and pyæmia, as a consequence of diffuse suppurative phlebitis.

Causes.—Some form of injury is, commonly, the immediate cause of phlebitis; a wound, as in operations involving the veins, phlebotomy, or the application of a ligature. But some constitutional or blood-condition probably predisposes, or may be the predominant cause, in most cases. This causative condition is apparently akin to that of erysipelas. Having regard to its etiology, phlebitis is thus also distinguished as *traumatic* and *idiopathic.*

Course and Terminations.—(1.) Absorption seems to prevail in some cases; the coagulum becoming centrally pervious, and a channel thus forming, through which the venous circulation is re-established. (2.) Or, obstruction continuing, the vessel becomes impervious, and, shrivelling into a fibrous cord, is obliterated; gangrene threatens; in proportion to the degree of occlusion, its suddenness, and the size of the venous trunk. Such are the consequences of *Adhesive* phlebitis, more especially. *Suppurative* phlebitis often proceeds to further consequences, local and constitutional:—(3.) Rupture of the vein, with the formation of abscess in the surrounding cellular texture, and sloughing. (4.) Pyæmia is announced by rigors, great prostration, rapidity of pulse, with other symptoms of purulent infection; followed frequently by a fatal issue.

Treatment.—Local blood-letting, by means of leeches applied along the course of the vessel, and warm fomentations may prevent adhesive phlebitis, by promoting resolution of the inflammation before fibrinous exudation and coagulation have supervened. Subsequently, alkaline salines seem to induce disintegration and absorption of materials occluding the vessel. But the administration of calomel and opium is of doubtful efficacy. Fibrinous exudation may, indeed, be thus prevented, in some measure; but the peril of *diffuse* suppuration will be facilitated. *Abscess* arising, it must be opened forthwith; and chronic œdema may be restrained by bandaging, or removed by blisters. Stimulants are more needed, and earlier, than in Arteritis; and they are less objectionable with relation to gangrene, which is rather a tendency only of the disease, than actually resulting from venous obstruction. *Pyæmia* cannot be overcome by any known remedial measures. Besides the treatment by opium, wine, or brandy and egg mixture, freely administered, Pirrie recommends the tincture of the muriate of iron, in doses of 25 drops every four hours.

THROMBUS—THROMBOSIS or THROMBALLOSIS.—The term *Thrombus*, literally signifying a blood-clot, is applied to the formation of a clot within a blood-vessel,—whether an *artery* or a *vein;* thus giving rise to arterial thrombus (Fig. 179), as after the ligature of an artery, or to venous thrombus, as after the wound of a vein, for instance, by venesection. But venous thrombi are more common in connection with disease, and have a wider pathological significance.

Venous thrombosis, or the coagulation of the blood within a vein, may certainly arise independently of inflammation of the vessels; and it may be doubtful whether phlebitis is ever attended with coagulation of the blood within the vessel. Virchow's observations and

experiments have, perhaps, shown that phlebitis is an inflammation which affects the walls, and not the contents, of a vein; for when the blood is excluded from the vessel, no exudation is deposited within the cavity, yet the walls become thickened; when again the blood flows through the vein, no coagulation takes place, even although suppuration may have ensued in the wall of the vessel, and abscesses, like variolous pustules, bulge into its interior. The so-called *adhesive*, or clot-forming, phlebitis may therefore be regarded as simply *thrombosis*, without inflammation of the vein; while, as one of the transformations of a thrombus, the *softening* and disintegration to which the blood-clot is liable, will give rise to the ordinary so-called *suppurative* phlebitis.

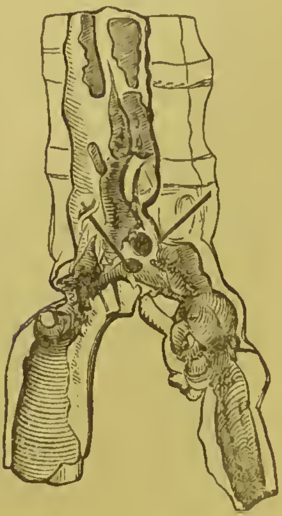
Fig. 179.*

Causes of Thrombus. — Clot-formation within a vein,—when not occurring to a limited extent, as for the repair of wounds —seems to proceed from some blood-condition, in which there may be an increased proportion of fibrine in the blood, or certainly a hyper-tendency of the fibrine to coagulate. Then an intra-venous clot is apt to form, plugging the vessel, and extend into continuous veins. Usually, a venous thrombus extends up to the next larger-sized vein; there tailing off with a pointed extremity. But it may pass beyond the mouth of the branch into the trunk, enlarging and continuing in the shape of a thick cylinder, in the direction of the current of blood. (See Fig. 80.) This prolonged thrombus may be as big as the thumb, the original (autochthonous) thrombus not thicker than a knitting-needle; as when, from a lumbar vein, a plug extends into the vena cava. The morbid blood-conditions which may give rise to the production of thrombus depend apparently on some constitutional predisposition connected with the blood-elaborating processes, as in phthisis and cancer; in both of which diseases Bouilland states that thrombosis often occurs. But *exciting* causes bring this blood-condition into operation. Thus, a feeble circulation of the blood, whether referable to a weak heart or to weak, inelastic vessels, may be partly a predisposing, partly an exciting cause of clot-formation; by favouring the coagulation of fibrine from the sluggish blood-streams in the veins. A more immediate causative influence may, however, be brought to bear, by pressure on the veins, as by a tumour, or the contraction of inflammatory deposit, as in the cellular texture around a wound. On the other hand, the dilatation of veins may have a similar effect, as witnessed in the plugging of varicose veins, and varicose aneurism. Laceration of the vessels is another fertile cause of thrombus, as in the uterine veins after expulsion of the placenta from the uterus, or from other occasions

* Middlesex Hosp. Mus., S. vi. 104. Thrombosis of the abdominal aorta and iliac arteries, showing firm cylinders of fibrine, plugging these vessels. From a woman, who died after amputation of the leg for gangrene. The cause of the thrombosis was pressure on the aorta, produced by a large uterine fibrous tumour.

of wound or contusion; giving rise to primary *traumatic* thrombi. (Fig. 180). Any roughness or projections within the veins, as from phlebitis, will invite the disposition of fibrine; and inflammation affecting the cellular texture around the veins, may induce thrombosis and plugging within them, as at the base of an extending ulcer.

FIG. 180.*



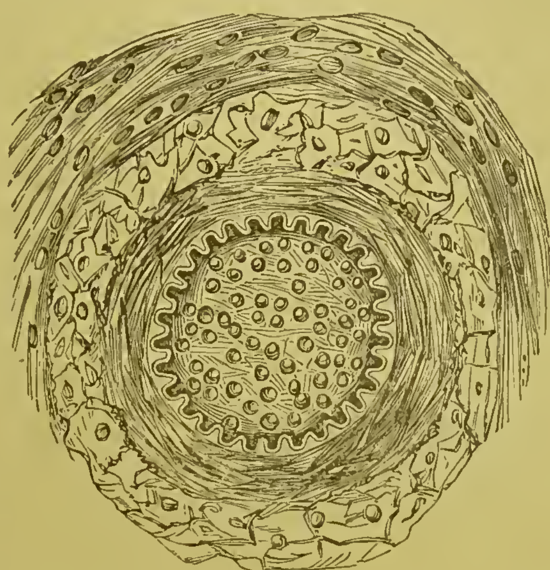
Symptoms.—The symptoms of venous obstruction, coincident with intra-clot production, or thrombosis, are just those of adhesive phlebitis: induration, in the form of knotted cords, when the veins are felt under the finger, with some tenderness, purplish redness, and heat in the course of the vessels. These symptoms are more perceptible if the veins be superficial; as from thrombus of the median, the cephalic, and basilic veins, sometimes, after venesection. Obstruction in the deep veins will be indicated by œdema, affecting perhaps the whole limb, which feels hot and dry, is usually flexed, and extension occasions great pain. These symptoms are generally referable to some accompanying injury; a contusion, wound, or fracture. Similar symptoms may arise from inflammatory condensation of the cellular tissue around a vein, forming a tubular thickening, enclosing the vessel, but which is itself free of coagulum; and thus the *diagnosis* between peri-venous condensation, and intra-venous clot or thrombus, may be difficult or impossible.

Transformations of Thrombus.—An intra-venous clot is liable to either of two transformations. It may possibly become *organized*, by the formation of connective tissue, apparently through elongation and attenuation of the white blood-cells into filaments (Fig. 181), with the development of capillary blood-vessels passing from the walls of the vein, as in the repair of a wounded vein. But, generally, the clot tends to become *softened*, the fibrine undergoing a disintegrative transformation into a thick yellow fluid, puriform, or resembling pus in appearance, yet consisting of fluid fibrinous detritus or molecular matter, without pus-corpuscles or a vestige of any cellular element. The softened thrombus thus having assumed the consistence of purulent matter, now presents the symptoms of "suppurative phlebitis." This change begins usually in the coagulum first deposited, the oldest

* Middlesex Hosp. Mus., S. vi. 111A. Thrombosis, with ulceration, of vena cava and iliac veins, from the entrance of two needles into the cava. The patient, an hysterical woman, aged twenty-one, had swallowed the needles. This was followed by remarkable alternations of temperature,—rising to 105·6°, and falling to 96·6°, thus showing a range of 9°. Œdema of the lower extremities appeared, with conspicuous enlargement of the superficial veins; this occurred in the left limb on the fifteenth day, and in the right limb on the forty-fifth day. This state was persistent. Signs and symptoms closely resembling those of pericarditis were developed on the day when the left limb thus became affected. Aching pains in various regions of the spine, accompanied by faintness or syncope, were sometimes attended with rigors or with a high degree of pyrexia. Abdominal pain and diarrhœa, delirium, or a state of unconsciousness supervened, and death took place on the fifty-ninth day. (See also Trans. Clin. Soc., vol. viii.) (Dr. Henry Thompson.)

part in the thrombus, although sometimes the softening may commence in the coagulum last formed. An *apparent* suppurative phlebitis may, therefore, arise from the softened transformation of a thrombus, without any inflammation of the vessel, according to the interpretation which Virchow originally advanced; but Billroth affirms also the possible conversion of a thrombus into pus—that if the blood-cells in a thrombus have the power of changing into connective tissue, so may pus be formed from them, just as from cells wandering out of the vessels. This purulent, not puriform, transmutation of a thrombus induces inflammation of the vessels, the walls becoming thickened, and thus a *real* suppurative phlebitis is established. The same eminent pathologist is led by his observations to refer the origin of most venous thrombi to very acute inflammation of cellular tissue, and in his experience the changes which the clot within the vessel undergoes, are the same as of the inflammatory new formation. If the latter becomes organized into tissue, so also is the clot developed into connective tissue; but when the inflammation issues in suppuration, the thrombus also softens and suppurates.

Fig. 181.*



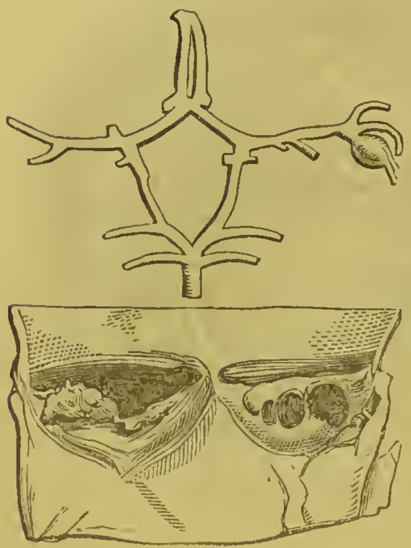
We proceed to trace the yet further history of Thrombus from Virchow's view of softening by fibrinous disintegration.

Embolism.—The friable thrombus which results from softening of a blood-clot within a vein, is ready for disintegration or disruption into fragments of variable size, any one or more of which shall be transmitted by the blood-stream through other veins into parts perhaps remote, until reaching vessels too small for their onward passage, the fibrinous fragments there become impacted; this process of fibrine-transference and impacted state of the vessels is known as *embolism*, and the impacted fragment is named an *embolus* or *embolon*. These terms are, however, applicable also to the similar history of a thrombus-fragment in the arteries, which are thus subject to embolism (Fig. 182); and an embolus may be any other foreign body, as a bit of atheromatous or calcareous matter. But it is only under certain circumstances that embolism from the disintegration of a thrombus seems likely to arise. The thrombosed vessel itself is occluded, so that no fragment of the clot can be carried thence by the blood-stream into the circulation. But when the thrombus is prolonged into

* Transverse section of an artery, closed with a thrombus, six days old, showing white blood-cells, mostly round and greatly increased in number, the red blood-cells having disappeared; also cell-infiltration in the outer coat of the vessel and surrounding connective tissue. 300 diam. (Billroth.)

another vein, and thus exposed to the force of the current, *there* a portion may be torn off, or a fragment dislodged and carried away. (See Fig. 80.) It would appear also that the fragments must be of sufficient size, in order to plug up the vessels, or at least the capillaries, in the parts to which they are borne; molecular matter washed off the thrombus by the blood-stream may hardly have any embolic effect. Embolism, therefore, is in no way necessarily, and invariably, consequent on thrombus softening. When, however, fragments of fibrinous coagula are once launched into the systemic venous circulation, they are generally transported through the larger veins and vena cava, into the right cavities of the heart, passing thence through the pulmonary artery into the lungs, but lodging at some point of bifurcation in the branches of the artery, or reaching the pulmonic capillary vessels. Here they constitute *red infarctions*, hæmorrhagic possibly, from rupture of the vessels impacted. In whatever portion of the pulmonary circulation the vessels are thus suddenly blocked up, the deprivation of blood is attended with more or less urgent dyspnœa and a fit of coughing, as the immediate symptoms of pulmonic embolism. In other organs or parts, an impacted embolus gives rise to different symptoms, according to the functional disturbances induced; in a limb, for example, sudden pain or numbness will be experienced, and the part becomes cold and enlarged with œdematous swelling, below the seat of venous obstruction.

Fig. 182.*



Red embolic infarctions are subject to various changes. A healthy fibrinous clot induces slight thickening of the wall of the vessel in which it is lodged, apparently as the result of mechanical irritation; but the intrinsic changes of the clot appear to depend on the size of the embolus, and the freedom of the collateral circulation, or a thrombosed state of the adjoining vessels. When the clot is small, and well supplied with blood, it may possibly disappear; or, gathering perhaps some fresh deposition of fibrine around itself, the clot may become organized into connective tissue. But when the embolus is deprived of blood, by thrombosis extending around it, the clot disintegrates, and is transformed into a granular yellow dry mass, forming the *yellow dry infarction;* which becomes encysted, and may pass into calcareous degeneration. Embolic deposits of fibrinous matter in the capillary vessels may give rise to *metastatic abscesses*, *e.g.*, in the lungs (see Fig. 81) and other organs; preceded by, and accompanied with, the symptoms of pyæmia, or purulent infection of the blood. Yet it should be remembered that *pyæmic* infection, so called, is only one of the possible events in the vital career of Thrombus.

* St. Thomas's Hosp. Mus., N. 62². Embolism of the posterior branch of the right middle cerebral artery. The embolus is about the size of a small pea. The aortic valves are shown in the same preparation; they are extensively diseased, and from them the embolus was probably derived.

The *treatment* of Thrombosis and Embolism will, of course, be as widespread as their pathology, chiefly in connection with wounds of arteries and veins, and of arteritis and phlebitis, so named.

PHLEBOLITHS, OR VEIN-STONES.—Concretions are not unfrequently formed within various veins, more particularly in the iliac and its branches. Consisting of fibrine, which at length calcifying form concretions, these bodies are of a roundish shape, and the size of a pea or bean; they are either free, or attached to the interior of the vessels, cropping in and gathering more fibrine around themselves as the stream of blood eddies slowly by. One such body, situated in a principal vein, as either common iliac, might become a cause of serious obstruction to the return of blood from the whole lower extremity.

The *diagnosis* would be difficult or impossible, the occluding concretion being discovered only after death. Fortunately, however, when venous obstruction is gradually established, an adequate compensation is provided by the simultaneous enlargement of other veins, as collateral channels, for the return of blood. The obscurity of diagnosis, and this compensatory circulation, render vein-stones of little practical interest.

LYMPHATICS AND GLANDS.

CHAPTER XXX.

LYMPHATITIS.—TUMOURS.

LYMPHATITIS.—INFLAMMATION OF THE LYMPHATICS, LYMPHANGITIS, OR ANGEIOLEUCITIS.—*Structural Conditions.*—The walls of the lymphatic vessels, when inflamed, are thickened and softened, the surrounding cellular tissue is infiltrated with fibrinous exudation, and the capillaries are injected. Similar exudation mingling with the lymph within the vessels, forms a rosy clot, obstructing their interior. *Suppuration* often ensues, *limited* as an abscess, or a chain of abscesses along the course of the vessel; or as *diffuse* infiltration.

The *Symptoms* are referable both to the vessels affected, and to the part. Inflamed lymphatics present purplish-red linear streaks, tortuous and intersecting, forming an arborescent appearance, not necessarily continuous with the source of inflammation, but running up to the neighbouring lymphatic glands, which also become involved. Erysipelatous patches frequently appear, having the same distribution, and render the islets of unaffected skin between the lymphatics more conspicuous. These red lines are hard and cord-like under the finger, and beset with a spongy swelling—the surrounding infiltration. A hot, burning pain, and tenderness on pressure, also corresponds with

the course of the vessels. These symptoms are more marked when the superficial lymphatics are affected, and may be scarcely perceptible when the deeper lymphatics are principally the seat of inflammation. In the limbs, the superficial lymphatics on the flexor aspect are most affected; the vessels being seen coursing up the front of the forearm and inner side of the arm to the axillary glands, or along the inner side of the leg and up the thigh to the inguinal glands. Beyond these glands, lymphatitis rarely extends, in the limbs. *Suppuration* is made known by the usual symptoms of abscess, or by those of *diffuse* suppuration, in the event of this condition prevailing. Considerable œdema of the part—possibly a whole limb—supervenes, as the vessels become occluded; and this symptomatic condition is more intense with inflammation of the deeper lymphatics. The *general* symptoms will be those of inflammatory fever, soon exchanged for prostration, or sinking into the collapse of pyæmic infection.

Causes.—Usually arising from some form of injury—a wound, or friction, or from the absorption of some poisonous matter, as by a dissection wound—the external and local cause of lymphatitis is frequently a trifling lesion. Some constitutional condition would appear to prevail in most cases; and this, probably, is of the erysipelatous nature.

In persons of a broken constitution, and those who are in a low state of health, inflammation of the lymphatics readily occurs, and often from scarcely perceptible external causes; the pressure of a tight boot, inducing a few reddish streaks on the inner side of the leg and thigh, with swelling and tenderness of the inguinal glands; or a slight abrasion on the hand being followed by similar inflammation of the lymphatics along the inner side of the arm, extending to the axillary glands.

Course and Terminations.—(1.) Resolution takes place not unfrequently, even in those who seem most susceptible of the disease. The reddish streaks fade away, and the œdema subsides. (2.) Or, inflammation having ceased, the indurated cords may remain, with brawny swelling, for some time. (3.) Suppurative lymphatitis often leads to the formation of abscesses in the surrounding cellular texture, and possibly sloughing. (4.) Pyæmic infection is a frequent consequence, proceeding, probably, from the direct transmission of pus from the interior of the vessels.

Treatment.—The application of a few leeches, along the course of the vessels, may be appropriate in the absence of an erysipelatous tendency; but warm fomentations, elevation of the limb, and rest will always be suitable, and generally prove sufficient to reduce the inflammation. Alkaline salines and other mild depletory measures are auxiliary at an early period.

Abscesses should be opened without delay, and chronic œdema is best overcome by careful bandaging and blistering, or the application of mercurial ointment. Stimulants will soon become requisite in the course of this disease. Wine, brandy, and ammonia must be freely administered; the latter, I think, has a depressing influence, when continued for any length of time; and any stimulant supplies only a prop, to be withdrawn in proportion as nourishing food can be taken and assimilated. The treatment of pyæmia, as a consequence of lymphatitis, presents nothing peculiar.

INFLAMMATION OF LYMPHATIC GLANDS.—ADENITIS.—*Structural Conditions.*—Inflammation of the lymphatic glands differs in no important particular from that of the lymphatic vessels. Their structural resemblance explains this pathological affinity, for these glands each consist of lymphatic vessels in the form of a network, connected by cellular tissue into a dense mass, enclosed in a cellular capsule. The lymphatics, entering a gland and forming the network, are again collected into lymphatic trunks issuing from the gland. Capillary blood-vessels ramify on this network of lymphatics, and are thus brought into an intimate relation with them, anatomically and physiologically. Inflammation of the lymphatic glands is attended with some thickening of the conglomerated vessels, and infiltration of the interstitial cellular tissue with fibrinous exudation and cells, but seldom with any permanent obstruction of the interior of the vessels. Suppuration not unfrequently takes place, forming an abscess, either centrally in the substance of the gland, or in the external and surrounding cellular texture.

The *symptoms* are simply those of ordinary inflammation; the gland becomes swollen, hard, and painful, with, perhaps, a blush of redness and heat in the superimposed integument. Induration is less notable, owing to the naturally firm consistence of the lymphatic glands; but they may acquire even a bullety hardness, as the inguinal glands in connection with an indurated syphilitic sore. Softening often succeeds in ordinary adenitis; and with suppuration, the usual symptoms of abscess supervene. Œdema commonly occurs in the part below, and proportionately as absorption becomes obstructed. The constitutional disturbance is the inflammatory type of fever, and often more acute than with inflammation of the lymphatic vessels.

Causes.—Usually ensuing as a continuation of inflammation along the lymphatics, adenitis sometimes arises independently, from an injury, or from absorption of noxious matter, not affecting the intermediate vessels. A sprain or an ulcer may thus induce inflammation of the glands distant from the seat of either; as the inguinal glands, when the foot or shin is the source, the intervening lymphatic vessels remaining unaffected.

Course and Terminations.—(1.) Resolution occurs in many cases of ordinary inflammation. (2.) Chronic enlargement and induration is not uncommon. (3.) Suppuration may be followed by sloughing, and exposure of the glands, as reddish-grey, fleshy masses, notwithstanding the destruction around them.

Treatment.—Leeches are seldom necessary; fomentation, rest, and relaxation by position generally being sufficient to resolve the inflammation, aided by mild depletory measures medicinally. *Suppuration* threatening, the same treatment should be continued, and warm spongio-piline formentations or poulticing having been assiduously employed for a few days, a bistoury should at once be introduced, and any matter set free ere burrowing has taken place. Fistulous tracks are more apt to form with suppuration around the gland; and stimulating injections or solid nitrate of silver will then, perhaps, succeed in exciting healthy granulation so as to close these passages; failing which, they must be slit up and healed from the bottom. *Chronic* induration of the lymphatic glands is best dispersed by the occasional application of iodine paint; but if suppuration has taken place, and perhaps

circumferentially, with fistulous openings through which portions of the glandular mass protrude, it will be requisite to destroy such a mass by introducing a stick of caustic potash into its substance and turning it freely about. Thus also any induration may be dissolved. A stimulant and tonic plan of treatment must take the place of any depletory measures, during suppuration or in chronic induration; and removal of the latter may, perhaps, be aided by iodide of potassium in conjunction with this treatment.

Extirpation of the lymphatic glands in a state of chronic induration becomes necessary as a last resource. I have removed such glands; in particular, a conglomerate bunch of axillary glands, which was found to consist of degenerate gland-tissue, enclosing spots of yellow, curdy pus, and cretaceous matter. Fistulous openings afterwards proved troublesome, but these closed under stimulating injections.

Enlargements, and Tumours of Lymphatic Glands.—*Lymphoma.*— The term Lymphoma is applied to a class of tumours which in structure resemble that of the lymphatic glands. Commonly, this form of growth consists of a *chronic enlargement* or hypertrophy of the lymphatic glands themselves; but, associated with this condition, there are often a number of similar growths, in the form of distinct *tumours*,—beyond the normal number of enlarged glands, yet having the lymphatic structure. Lymphomatous tumours may also occur in parts of the body unconnected with the absorbent glands.

The *characters* of lymphoma are similar to those of scrofulous enlargement of these glands,—as already noticed among the numerous local manifestations of scrofula; but for accuracy of description I shall follow Billroth's account of lymphoma. For a long time the glands preserve their kidney shape, and remain isolated, although clustered. Continuing to enlarge, these glandular tumours unite and form a lobulated mass, of a firm and elastic consistence; tender perhaps, but scarcely painful. The growth may then be arrested, and the conglomerate mass remain; causing only more or less compression and functional derangement of the adjoining parts; or the tumour may slowly pass into caseous degeneration, with ulceration of the integument. All the lymphatic glands are not equally disposed to this disease; usually the cervical, less frequently the axillary and inguinal, most rarely the abdominal and bronchial. As forming in the axilla, the appearances were well marked in a case under Mr. De Morgan in the Middlesex Hospital. (Fig. 183.) The tumour occurred in the person of a man, aged forty-five, of apparently healthy constitution. It had been growing for about four years; was firm and elastic, but fluctuation could be felt at the most prominent part towards the outer side; the skin was there getting thin and bluish red, and adherent. The veins over the surface were enlarged. No pain or tenderness. The axillary artery could be felt above the tumour, and separate from it. After removal, the

Fig. 183.

mass weighed $4\frac{1}{2}$ lbs. On section, it was cystic, but had the characters of a fibrous tumour. Under the microscope, it showed the structure represented in Fig. 184; a fine alveolar fibroid stroma, containing lymph-corpuscles, like white blood-corpuscles, in abundance; curdy and fatty matter from degeneration was found in parts. Large cells, and of diverse form, here and there, like large granulation-cells, in other parts of the tumour seemed to indicate a transition to a sarcomatous growth.

On removing a lymphomatous mass, the constituent tumours are kidney-shaped or ovoid; and on section exhibit a greyish yellow colour, which by exposure assumes a reddish hue. The minute *structure* of these glandular tumours consists of an accumulation of lymph-cells, which have undergone proliferating development; with atrophy and rarefaction of the enclosing capsule and trabecular structure, which, in the form of a fine open fibrous network, contains the lymph-cells. (Fig. 184.) The blood-vessels remain, but their walls are much thickened. Thus the proper structure of the gland is destroyed. The cellular infiltration may be so considerable, as to resemble a gliomatous tumour.

Fig. 184.*

The *origin* of lymphoma is hardly ever congenital; but the tumour may occur from the first to the sixtieth year; usually, however, between eight and twenty years of age, and rarely after thirty. Some connection may be traced between lymphoma and leucocythemia, or an excessive development of white-corpuscles in the blood,—white-celled blood. Virchow refers leucocythemia, in such cases, to the excess of white-cells supplied by the hyper-plastic lymphatic glands. Billroth differs from this explanation; for with extensive tumours of the lymphatic glands, leucocythemia rarely occurs; and the glands being more or less completely destroyed, it is improbable that their functional activity should thus be increased.

Another form of lymphoma is also recognized by some pathologists, in which, with the same essential structure, the growth proliferates rapidly, and infiltrates the surrounding textures; the tumour appearing as a *fungoid* mass, and having a malignant character. These *medullary* lymphomatous tumours always recur after removal, and are almost always fatal.

The *treatment* of lymphoma in its ordinary benign form is much the same as for scrofulous enlargement of the lymphatic glands. Constitutional measures are more efficacious than topical applications. The patient's general health must be brought under the influence of iron and quinine, cod-liver oil, and a nutritious diet; reinforced by the hygienic *régime* of good air, such exercise as the strength can bear, and other invigorating resources. Iodine, of more remedial value when used externally, may be applied, as iodine paint or ointment, with some hope of thus reducing the size of a lymphomatous tumour. Its removal by operation will scarcely ever be advisable,

* Lymphoma, or Lymphadenoma—Mr. De Morgan's case, examined by Mr. Henry Arnott. (Trans. Path. Soc., vol. xxii.)

whether on account of the extent and ill-defined nature of the mass, or the situation in which it may be placed; as occupying one or both sides of the neck, or the armpit and side of the chest. Sometimes the tumours may be shelled out or enucleated with the fingers; in other cases, where the mass is conglomerate and softened, a considerable dissection will hardly succeed in extirpating the whole. Here, also, the growths are apt to return; and thus even the apparent success of the operation may ultimately be defeated.

BONES.

CHAPTER XXXI.

FRACTURE.

FRACTURE.—*Structural Conditions.*—Fracture is a solution of continuity of the osseous texture, suddenly produced, and by some degree of external violence, or perhaps muscular action; the broken ends of bone being more or less contused or lacerated by the act of breaking. Fractures differ essentially in regard to the mode of their reparation, according as they are unaccompanied, or attended, by an open wound communicating with the fracture; the one being termed *Simple*, the other *Compound*. *Complicated* Fracture is also a recognized distinction; when the injury to the bone is accompanied with injury to other parts, as important blood-vessels or nerves, an internal organ, or extends into a joint, or is accompanied with dislocation. But any such additional injury is not an essential condition, as pertaining to the pathology of Fracture.

FIG. 185.*

In its extent, a fracture generally passes completely through the bone—*complete* fracture; occasionally, it is limited to part only of the whole thickness of a bone—*incomplete* or, as it is sometimes aptly termed, "green-stick" fracture. (Fig. 185.) In direction, the line of fracture may be *transverse*, *oblique* (*a*), or *longitudinal* (*b*), as compared with the axis of a long bone. (Fig. 186.) If there be more than two, perhaps several, fragments, the fracture is *comminuted*. *Impacted* fracture is that

* St. George's Hosp. Mus., 1, 124. Incomplete fracture of the right tibia, in a man aged thirty-six years. Death from pyæmia, consequent on abscess in the joint, from other injuries. Another almost *unique* case of green-stick fracture may be here mentioned. An *incomplete* fracture of the clavicle; the bone being broken on one side, and bent on the other, in its outer curve. This injury occurred in the person of a boy, who, in consequence of severe injury to the brain, died thirty hours after the accident. (St. George's Hospital Mus., 1, 75. B. C. Brodie.)

Yet another incomplete fracture of the clavicle (1, 76) was found in the body of a

condition wherein one fragment is wedged into another, the compact structure being driven into the cancellous texture. (Fig. 187.) An aperture made through a bone, as by a ball in gunshot wound, is sometimes named *a perforated* fracture.

Fig. 186.

Generally, *displacement* of the fragments, in some degree, occurs with fracture; or subsequently, by muscular action or the weight of the limb. Displacement may be transverse, oblique, longitudinal, angular, or rotatory, as compared with the axis of a long bone; or a depression, in the flat bones of the skull.

Fig. 187.

With fracture, the medullary web—endosteum—is torn, and completely across in most instances; the periosteum is rarely much damaged. According to Paget's observations, the latter membrane is seldom stripped off the broken ends. Commonly, it is cleanly rent across at the same level as the fracture, and maintains its close union, having only its fibres somewhat frayed or pulled from their natural direction. Sometimes it remains entire, even with extensive fracture; and in this case, thickening, it contributes to the security of the repair of the injury.

Any damage done to the surrounding soft textures, and the temporary extravasation of blood, are concomitants of fracture, not pertaining to the lesion itself.

Separation of the *epiphysis* is liable to occur, at the extremities of long bones, as the ends of the humerus, and the lower end of the femur, and tibia; or the various epiphysial processes, as the olecranon and the acromion, may be detached. Fracture of this kind takes place at the line of junction between the epiphysis and the shaft, or the body of the bone. Hence its direction is transverse. Such fracture is possible only before the completion of ossification, and perfect continuity of the bone; during, therefore, infancy or youth, or probably not later than about twenty-one years of age.

Signs.—Fracture is attended with *mobility* of the broken portions of bone, and *crepitation*, a rough grating sensation, felt and heard, when the broken surfaces are gently moved in contact. Usually, the *normal outline of the limb* is altered, by the displacement of fracture and the speedy supervention of swelling, a disfigurement of *contour* which the experienced eye will frequently recognize at a glance; and there is more or less elevation or depression, also by the displacement and swelling at the *immediate* seat of fracture. Here also there may be more or less bruised discoloration of the integument, owing to ex-

child, aged five years. The under surface of the bone is fractured, but the upper surface remains and is bent outwards.

An incomplete fracture of the shaft of the radius will be found in the Museum of King's College, 1143-4; and an equally remarkable instance of such fracture in the ulna of a child, in St. Mary's Hosp. Mus.

travasation of blood, especially in fracture from direct violence; or some inflammatory redness may have supervened. *Shortening of the limb*, in some degree, takes place when one of the long bones, as in either limb, is broken (Fig. 188); and this resulting from the involuntary contraction of the muscles acting on the lower fragment, it takes place invariably, excepting under circumstances to be presently mentioned.

The direction in which the lower fragment is thus drawn is more or less upwards, and hence the shortening of the limb; but the displacement is determined by the linear action of the muscles; either in the resultant direction of their combined action in different lines, or in the direction of the stronger force of two antagonistic orders of muscles—the flexor muscles overcoming the extensors in either limb. Thus, in fracture of the humerus, betwixt its head and the insertion of the pectoralis major; this muscle chiefly, with the latissimus dorsi and teres major muscles, draws the lower portion of bone upwards, and inwards towards the thorax. With fracture of the femur in its middle third, the adductor muscles draw the lower portion upwards, and inwards behind the upper third of the femur; the approximation of the attachments of the adductors producing a certain fulness in the appearance of the upper part of the thigh, and which is more conspicuous by the shortening of the limb as compared with its fellow. When both bones of the leg are broken, the lower portions of the tibia and fibula are drawn upwards, and behind the upper fragments, by the action of the gastrocnemius and soleus as flexor muscles. Shortening of the forearm, in the opposite direction, may occur, but in a lesser degree, with fracture of the radius and ulna. Pain, and inability to use the limb, or broken bone, are *functional* symptoms of Fracture; but of equivocal value in aid of diagnosis.

Fig. 188.*

Diagnosis.—The pain may be insignificant at first, before swelling supervenes; and the power of motion be retained in the case of impacted fracture, or where one only of two companion bones is broken, the other acting as a splint. With fracture of the radius, in the forearm; or of the fibula, in the leg; the ulna or the tibia thus preserves some of the motions of the limb; although the special functions of either bone may be lost. But if the functional symptoms of pain and loss of voluntary power be well marked, they may each arise from other causes than fracture; as from dislocation, a bruise, or an attack of rheumatism, which thus far severally simulate fracture. The *physical* signs of Fracture may, *severally*, be *absent*. Mobility, in the case of impacted fracture; crepitation, if there be

* From Liston.

much displacement, or if soft tissue of any kind intervene between the fragments, or if some days have elapsed since the accident. In young children also, I have noticed that crepitus is less perceptible. The deformity of the limb, and the elevation or depression at the immediate seat of the injury, may be absent; as in impacted fracture, and in fracture without displacement; and these signs are less pronounced than usual, when one only of two companion bones is broken, the other resisting and supporting as a splint. Shortening also is absent in the latter two conditions, and takes place to a much less degree with impaction. The most difficult case is this: a fracture of one of two companion bones in the leg or forearm, and in a muscular subject, and when considerable swelling has supervened. There is no shortening and no angular deformity, no crepitation can be felt, and mobility of the broken portions is obscured by the swollen cushion of soft tissues surrounding the seat of fracture.

But if the signs of fracture be *present*, they may, *severally*, arise from other causes; with one exception, namely, mobility in the continuity of a bone. This can arise only from fracture. Crepitation may attend the play of the tendons in their sheaths, in connection with inflammation; but the creaking, jerking crepitation thus produced, differs from the rough grating of broken bone. The altered contour of the limb, and of the part at the seat of supposed fracture, and the shortening of the limb may arise from a previous fracture, interstitial absorption, or other disease of the bone, or from deformity, congenital or acquired, as rickets or mollities ossium. In the proximity of a joint, these signs may be due to dislocation; but the absence of crepitation and of mobility, or the fact of immobility, are the turning points of the diagnosis.

It appears, then, that no physical sign taken singly, except one—mobility—is pathognomonic of fracture, and that any one sign may be absent; but all these signs taken *collectively*, determine the diagnosis. Functional symptoms, singly or combined, are insufficient; yet their concurrence further establishes the diagnosis.

Separation of an *epiphysis* at the extremity of a long bone simulates *dislocation*, in regard to the deformity of, or closely adjoining, the articulation; but mobility and crepitation are distinctive. The age will also be suggestive.

Causes, external and internal; and effects of Fracture.—Fracture is produced, in general, by external force, suddenly applied, either directly to the part, or indirectly at a distance; but occasionally, it is the result of the sudden and powerful action of muscles, as in fracture of the patella, not unfrequently. *Predisposing* causes are numerous and very influential. Some relate to the functional uses of the bone; thus, the radius is liable to fracture in the manifold use of the hand; others are anatomical predisposing conditions, as the exposed position of a bone—the tibia, for example—and brittleness of the osseous texture, as a condition consequent on age. Separation of an epiphysis, as at the lower end of the humerus, is a species of fracture incident to youth. Certain blood-diseases also apparently have some predisposing influence in the production of fracture; rickets, syphilis, cancer, scrofula, and scurvy.

Fracture is attended with shock, in a greater or less degree, followed by reaction; or, if the latter be accompanied with exhaustion, a mixed state of prostration with excitement supervenes, constituting traumatic

delirium; which may be succeeded by tetanus. But these extreme consequences are uncommon; and usually the immediate shock of injury passes off, when the fracture is reduced.

Reparation.—Fracture is disposed to unite by a modification of the process of primary adhesion, namely, by osseous consolidation of the bond of union, unaccompanied by inflammation, as follows:—*Inflammatory* lymph, in small quantity, is first exuded round about the seat of fracture, rendering the cellular texture more succulent, and thus producing a swelling, which, however, is partly or principally due to the blood extravasated by the injury. This mixèd swelling gradually subsides; the exudation of lymph not continuing later, in most cases, than the second or third day. A period of inactivity—"brooding time"—succeeds, of uncertain duration, but which, in the adult, is rarely less than one week or more than two. Then the proper *reparative*

FIG. 189.

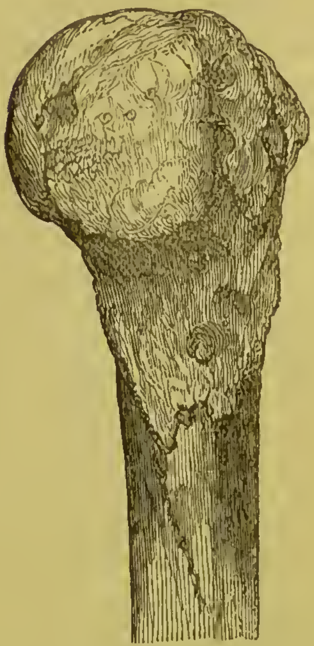
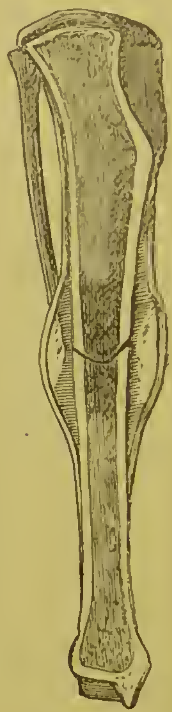


Fig. 190.

FIG. 191.

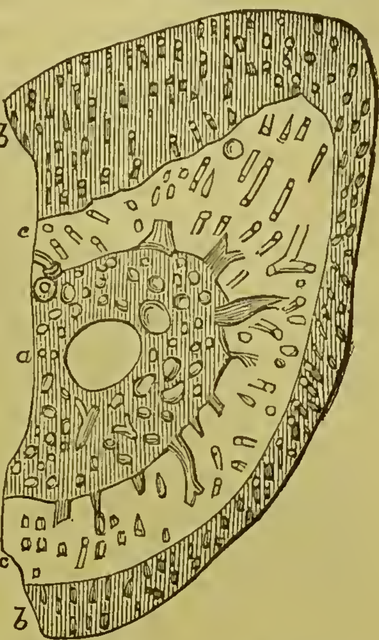


or ossifying lymph begins to flow. A layer of this lymph is deposited between the fractured ends of bone, which, undergoing development into fibro-cellular tissue, or perchance into cartilage, and thence, in either case, into bone, restores the continuity of the fragments; forming an intermediately connecting layer of bone—an "intermediate callus." This is the *only* callus, whether the fragments be in even apposition (Fig. 189) or overlap (Fig. 190). The full sufficiency of an intermediate callus is beautifully illustrated in both the specimens figured; oblique fractures of the humerus—the one a fracture through the great tuberosity and part of the shaft (Museum Roy. Free Hosp.); the other, a double fracture through the shaft (Sir A. Cooper). Neither an "external" nor an "internal" callus, therefore, is produced in the *human* subject, as was formerly supposed, excepting when the fractured limb or part is subjected to unusual motion during the process of repair, or when the original bone is diseased. Then, indeed,

lymph-forming callus may be thrown out around the seat of fracture, ensheathing the fragments as with a bony clasp (Fig. 191), and formed also as a peg within the medullary canal. The lymph deposited in either of these situations speedily ossifies. The walls of the fractured ends of bone remain still longer disunited. Either callus thus placed is formed *some time before* the intermediate lymph begins to ossify.

As to the long-mooted question respecting the source of callus, in the repair of fracture; the adjoining *bone* is the principal source of the new bone, callus being an outgrowth, in fact, from it; *e.g.*, between the adjoining ends of a broken tibia. (Fig. 192.)

Fig. 192.*



The *histological* process by which callus is produced, and becomes ossified, may be thus gathered from Billroth's observations. The ossific lymph at first consists of small round cells, which, as white blood-cells, have emigrated from the blood-vessels, along the course of the Haversian canals, within the fractured ends of bone, thus infiltrating them and overflowing between them, to form an intermediate callus; and, as the connective tissue in the osseous canals is continuous both with the periosteum and medulla, the wandering cell-infiltration within the bone is also continuous therewith, in the production of an external and an internal callus. Even beyond the periosteum, cell-infiltration may extend into the adjoining soft textures—muscles and tendons. The cell-formation may now undergo direct ossification, without previous development into connective tissue, or be transformed into cartilage, and thence ossifying, become bone. In adults, direct ossification usually takes place; in children, this change proceeds indirectly, through the medium of cartilage. Coincident with the cell-production in the fractured bone, the Haversian canals themselves exhibit certain changes: the walls of these osseous canals are gradually absorbed, but unevenly, as if gnawed out, and the canals thus become enlarged; the cells fill them, occupying the interstices of the connective tissue within the canals, and the enclosed blood-vessels increase by forming loops. If the canals were so entirely filled, or choked up, with cells, as to compress the blood-vessels, the bone might die; reparation thus proving abortive, and necrosis of the fractured end resulting. In what way the bone becomes atrophied, in the walls of the Haversian canals—concurrently with the production of callus—is unknown. Billroth suggests that the lime-salts may be dissolved by the production of lactic acid, whereby the carbonates and phosphates are changed into soluble lactate of lime; or, that the organic fibrous basis of the bone

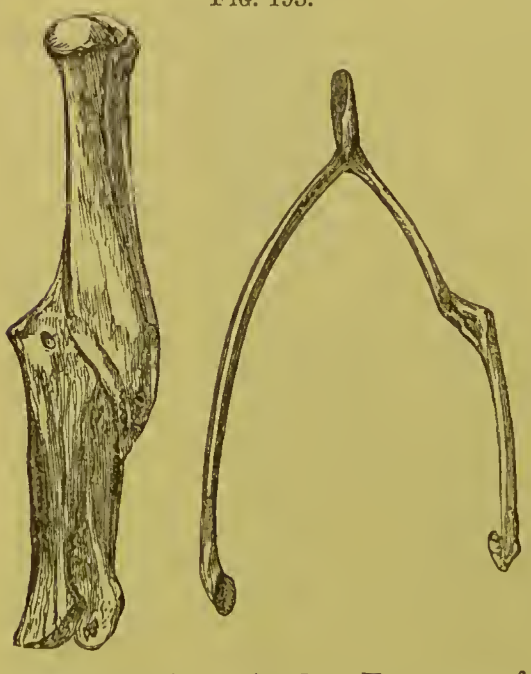
* Incomplete *transverse* section of the tibia of a dog; immediately adjoining a fracture, eight days old, artificially injected.—*a*, internal callus; *b*, external callus; *c*, cortical layer of the bone. 20 diam. (Billroth.)

may be dissolved by the cell-formation, thereby setting free and disintegrating the inorganic matter. The normal result in the fractured bone is, that the osseous texture becomes porous, from enlargement of the Haversian canals; after maceration, therefore, the dry bone appears rough, while young bone is deposited around the end, and in the medulla. The *periosteum* is used up, and disappears, in an ossifying external callus; this membrane, therefore, plays only a secondary part, instead of being principally productive, as was formerly supposed, in the formation of callus. If external callus proceeded alone from the periosteum, the portions of bone free of this membrane, as where tendons are attached to the bone, could produce no callus.

The new bone, wherever placed—between, around, or within—is true bone, and appears soon to acquire its proper miscroscopic characters. A new periosteum also is produced. At first firm, thin, and distinctly lamellar, it gradually acquires toughness and compactness of texture.

But the external and internal callus, when present, are *provisional* and *temporary.* They serve the purpose of two natural splints to retain the fractured ends in apposition while the intermediate or permanent callus is forming. When no longer requisite for this purpose, they are gradually withdrawn, the bone being fashioned off by absorption, and finally restored to nearly its original symmetry of outline. Little remains in after years to mark the scene of former injury, as if Nature, ever seeking to show her perfect work, were unwilling that any evidence of past imperfection should permanently remain on record. In several cases of transverse fracture of the tibia, through the middle of the shaft, which I have had under my care, the line of union could scarcely be seen or felt in the shin.

Fig. 193.



Thus, then, by a modification of the reparative process of adhesion, as in an incised wound, a simple fracture is reunited, and without regard to the particular direction of this lesion—transverse, oblique, or longitudinal,— or the position of the fragments—in even apposition or overlaying; anatomical conditions or contingencies of minor consideration, pathologically and practically.

It is, indeed, most interesting to observe, in corroboration of the provisional character of callus, externally and internally, that no such callus may be formed, even when the fragments are constantly subject to motion, as in *animals.* Fracture of the *furculum* or collar-bone in the common fowl may thus unite, as shown by a specimen in my possession. (Fig. 193.) Union of a fracture of the thigh-bone in

the same species of bird is also represented in the figure. Much thickening of the bone has occurred at the seat of fracture in this case, but no external callus; the sharp margin of the original fracture—an oblique one—being plainly seen at the line of junction by an intermediate callus, as the only bond of union.

Separation of an *epiphysis* readily undergoes reparation by osseous union.

Ligamentous union only takes place where, apparently, the vascular supply is insufficient for osseous repair; *e.g.*, in fracture of processes of bone, as the olecranon, and coronoid process of the ulna; or within a joint, as intracapsular fracture of the neck of the femur; or where the fragments are not retained in apposition, as in transverse fracture of the patella. Exceptional instances of ossific union may be met with in some such cases; as in an intra-condyloid fracture of the femur. (Mus. St. George's Hosp.)

The *period* for the completion of fracture-union is uncertain. The *average* period for the production of firm, and therefore apparently ossific, union may be said to vary from six to eight weeks; soft union taking place in a shorter period, and during childhood in perhaps a week or ten days. At the former time, I have known fracture of the clavicle united by soft callus. Generally, the process of repair is more speedy in the upper extremity than in the lower limb. Various adverse conditions, of a persistent character, may severally tend to retard or arrest the formation of callus. Causes predisposing to fracture have this additional effect. Such, perhaps, are age, and certain blood-diseases; *e.g.*, rickets and mollities ossium, syphilis, cancer, scrofula, and scurvy. Exception may, I think, be taken to the alleged mal-influence of rickets. In one case, especially, a very rickety child, four years of age, having met with fracture of the right femur; firm union, I found, had formed on the twenty-third day. Other causes, not predisposing to fracture, have, perhaps, the same tendency to prevent union. Such are febrile disturbances, erysipelas, starvation, pregnancy, and certain local conditions; as muscular action, frequent movement of a fractured limb, the direction of fracture as facilitating the recurrence of displacement, and the intervention of a piece of muscle, or dead bone, between the fragments.

The *Prognosis* of Fracture, as a lesion healing by a modification of the process of primary adhesion, is favourable. Otherwise, it will be determined by a due consideration of all those internal causes, which in their operation of retarding or arresting the formation of callus, thus perpetuate the injury. Sometimes the shaft of a bone becomes atrophied, when the nutritious artery is implicated by the fracture.

Treatment.—Immediately after Fracture, the occasion for Surgical interference is urgent. The hard and rough portions of bone, subject to the action of muscles, or other movement, are apt to lacerate and bruise the surrounding textures. This state of the part is more provoked by fracture accompanied with displacement, and when the broken ends of bone are pointed, as in oblique fracture. Hence arises increased and continued pain, spasm of the muscles, hæmorrhage and tension; or inflammation, advancing so far as to prevent the formation of reparative lymph at a subsequent period. Compound fracture may be produced, by either fragment piercing the skin. Shock also, which would have been slight and transient, is perpetuated. The rule of

treatment as to time was, and is still, I believe, with some Surgeons, to postpone any attempt to *set* the fracture at rest, until after the swelling itself—resulting from the injury—has subsided or been subdued by topical antiphlogistic measures. Some hours or even days, it is alleged,* as a general rule, should be allowed to elapse for the realization of this purpose. The utter fallacy of this injunction is obvious, the cause of increasing swelling still remaining in operation.

After Fracture, the subject of the accident should not be moved unnecessarily. If a lower limb be the seat of fracture, it is important to wait until a suitable conveyance can be procured. A litter is best fitted to carry the person, without any jerking movement, which would inevitably damage still more the already injured soft parts. This consideration will be the more important, according to the oblique direction of the fracture, and the amount of displacement. The production of compound fracture may thus be prevented. Hence, also, the limb should be properly secured, by tying it to its fellow, during the journey, however short, to an hospital or to home. The dress must be cautiously removed, and particularly from off the fractured limb, by ripping up the clothes. It may be advisable to aid the vital powers in recovering from the shock of injury, by the administration of stimulants; wine, brandy, or ammonia.

The pathological analogy of simple Fracture to an incised Wound, as a solution of textural continuity, and the natural mode of healing in both these lesions, by a process of reparation essentially the same, namely, primary adhesion, at once suggests the two Rules of Treatment.

(1.) *Reduction* and *Coaptation*, or the adjusted apposition of the fractured ends of bone. This condition implies a *suitable position* of the limb, to relax, as far as possible, any antagonistic muscles, which, by their spasmodic action, retain the fragments in a displaced position. It also implies some *extension* of the limb, with *counter-extension* or passive resistance, sufficient only to bring the fractured ends of bone parallel, end to end; a procedure which is designated the "reduction" of Fracture. Coaptation or "setting" is then readily effected.

(2.) *Maintenance of Coaptation* during the process of reparation, including the solidification of the callus. This still presupposes a suitable position to prevent re-displacement by the spasmodic action of any antagonistic muscles. But it also implies the employment of suitable retentive appliances, or *retentive apparatus*; and *both*, to insure *rest*. This is, obviously, only the continued fulfilment, and completion, of the former rule of treatment.

Certain *exceptions* to both the foregoing rules of treatment are to be observed. Considering the purpose of reduction, it can be necessary only in cases of fracture with displacement. Fracture without displacement, as when the lesion is transverse, and the ends of bone are broad and remain in contact, cannot require reduction. Such is sometimes the case in fracture of the lower part of the shaft of the femur. Then again, if one only of two companion bones, articulated together at either end, be broken, the remaining one renders any adjustment by extension and counter-extension impossible. In fracture of the fibula, especially if high up, the tibia has this restraining

* Chelius, by South.

effect. With fracture of the vertebræ, displacement cannot, and ought not to, be reduced. In *all* other cases, the reduction of Fracture is our first consideration in its Treatment. With displacement, angular or rotatory, the kind of reduction is obvious. With shortening, extension and counter-extension are required.

Reduction.—The limb should be placed in a *suitable position*, not with the view of relaxing all the muscles, for that is impossible. No position can possibly relax "the whole set of muscles belonging to, or in connection with, the broken bone;" as was recommended by Pott. On the other hand, the alleged unimportance of relaxing those muscles which resist the reduction, as taught by Desault, would be a serious error. The principle inculcated by Sharp and Pott will ever guide the treatment of Fracture, in this respect. The limbs should be *semi-flexed*, or placed in that position which is natural to the part in a state of perfect repose. In sleep, the limbs are partly flexed, obviously, to relax the flexor muscles, which naturally overbalance the action of the extensors. By this attitude of the limb, if complete reduction cannot be accomplished in the first instance, the fracture may be partially reduced, and the ends of bone placed at rest; and thus in a position less hurtful to the surrounding soft textures. Indeed, in some cases, when the muscles which resist reduction become relaxed, the ends of bone almost fall into easy apposition. They coapt, or adjust themselves into contact.

Extension and *counter-extension* are necessary only in so far as a suitable position is not of itself sufficient to effect reduction. So co-operative, however, is the relaxation of any resisting muscular action, that it has been, and I believe still continues, an open question with some Surgeons, to what *part* of the limb the forces of extension and counter-extension should be applied? Boyer advocated the application of extension to the limb *below* the articulation with the lower fragment, and counter-extension *above* the articulation with the upper fragment. Thus, that in fracture of the leg extension should be applied to the foot, while counter-extension fixes the thigh; in fracture of the thigh, extension should act on the leg, while counter-extension fixes the pelvis. For it is alleged that were these opposite forces applied directly to the broken bone, the pressure of grasping the limb so near the fracture would excite the muscles to spasmodic resistance. But the English School has, ever since the time of Pott, urged the superior importance of flexing the limb; a position which necessitates the application of extension and counter-extension *directly* to the broken bone; if in the leg, to the leg; if in the thigh, to the thigh.

The extending force should not be forcible, but moderate, and moderated according to muscular resistance; equable, not jerking; and gradually increasing. Applied also, at first, in the direction of the lower fragment, the natural position of the bone is to be thus gradually regained, care being taken to restore the natural length and shape of the limb. Duly observing any deformity of the other limb, congenital or acquired, advantage may be taken of this opportunity to reduce the fractured limb to a corresponding condition, whether of length, shape, or both. Extension cannot prove effectual unless accompanied with counter-extension, equal and opposite.

If the fracture be *incomplete* and the bone only bent, as happens sometimes in young children, reduction should not be accomplished all

at once, but by degrees; each adjustment being secured by a suitable retentive appliance, placed so as to oppose the re-curving of the bone. In all other cases, reduction may be accomplished according to the directions just given.

Coaptation of the fractured ends of bone is effected by the act of reduction in some cases. Muscular resistance having been overcome, aided by a proper position of the limb, the ends of bone readily come together, or they are easily adjusted by a little gentle manipulation. Any rough handling would further damage the soft textures round about the fracture. The ends of bone being brought parallel, their contact is announced by crepitation. This sensation and audible sign also assures the Surgeon that no portion of soft texture, as muscle, intervenes between the fragments; a condition which would impede or prevent their union. Adequate extension and counter-extension must, of course, be continued, during the applieation of any retentive measures; and in some cases subsequently, as will presently appear.

To *maintain Coaptation*—to retain the fractured ends of bone in adjusted contact—position must still be observed for the relaxation of any antagonistic muscles which would cause re-displacement. Flexure of the limb, in various degrees, according to circumstances, is generally most suitable; especially in fracture near a joint, where anchylosis appears inevitable. Splints of wood, pasteboard, leather, gutta-percha, or iron, and bandages, constitute the retentive appliances generally employed.

Splints, made of wood, are suitable in fractures of the lower extremities, where more strength of material is required, as in the long splint of Desault, modified by Liston, for fractures of the thigh; and the tin trough, or Liston's modification of McIntyre's splint, is well adapted for fracture of the leg. Bauer's wire-splints offer some advantage, in their capability of adaptation to the limb. Pasteboard, leather, or gutta-percha splints are suitable for fractures of the upper extremities.

Splints are not always indispensable. In one or two fractures, coaptation can be maintained effectually by position and bandages alone; for example, fracture of the clavicle. *Two* companion splints are generally requisite, one on either side of the fractured limb. Each should be broad enough to cover and protect the whole depth of the limb, but not to double over it. If too narrow, or too broad, the bandage applied will either exercise undue pressure, or not support the unprotected soft textures, between the splints. In point of length, the splints should extend over and beyond the joint at either extremity of the broken bone; so as to fix it steadily, not by pressuro on the seat of fracture, but by securing both these joints. With fracture of the thigh, the hip and knee; with fracture of the leg, the knee and ankle, are to be thus secured. "The true and proper use of splints," observes Pott, "is to preserve steadiness in the *whole* limb, without compressing the fracture at all." Hence the above rule of practice, and which he first inculcated. Splints should be comfortably *padded* with some light yielding material, as tow, or cotton wadding; and more particularly over prominences of bone, to prevent sloughing. Over the seat of fracture, any pressure is especially apt to peril the intervening soft textures, already damaged; while to forcibly subdue a *rising end* of bone by pressure, will surely induce sloughing, and rarely prove mechanically successful. Its replacement is best effected by removing the cause of

such projection. Alteration of position, therefore, will be necessary to relax the muscles which are acting on the upper fragment, while the lower one should be adequately supported underneath. In certain fractures, this rising of either fragment is only apparent, and really due to the natural shape of the bone, as the arching forward of the clavicle; or it may be an acquired deformity, as convexity of the tibia, from rickets.

The splints having been well adjusted, they are secured in position by a *bandage*, evenly applied round the limb from below upwards, and with just sufficient pressure for *this* purpose. No further restraint is required, excepting in the case of a maniac or a delirious person. If the fracture be subcutaneous, and either fragment threaten to protrude through the integuments, that portion of the limb may be left uncovered, or the splints lightly retained by a separate roller, which can be readily removed without unbandaging the limb. No bandage need be applied *underneath* the splints, as was formerly practised, and is even now-a-days advocated by some Surgeons, with the view of preventing œdema. A bandage so placed becomes tense, as swelling inevitably ensues, and is thus apt to cause strangulation and gangrene. This result may, indeed, occur imperceptibly, and gangrene overspread the whole limb without any notable constitutional disturbance to arouse suspicion. Hence, also, in applying the bandage around the splints, in the first instance, some degree of yielding should be allowed for the supervention of swelling, the splints being bound with sufficient firmness only to prevent displacement of the fracture. The *roller*-bandage is commonly used, and it is available in all cases where the limb can be moved without displacing the fracture. But rather than risk displacement, the *tailed*-bandage of Scultetus is a convenient substitute. It consists of a series of short strips of bandage laid transversely under the limb. Commencing below, each strip is drawn round the limb, so as to partially overlay and secure the next in succession. This contrivance forms an adequately firm bandage, like the common roller, extending uninterruptedly along the limb; but neither allow of tightening and relaxation, here and there, as occasion may require. The *looped*-bandage is specially adapted for this purpose, and without moving the limb. Double strips of bandage are placed transversely under the limb, at short intervals apart. One end of each is passed through the looped extremity, and, being drawn sufficiently tight, is secured by tying it to the other free end. The splints are thus fixed by a series of ligatures, any one of which can be braced or loosened at pleasure, without altering the whole.

Extension must be maintained, in *some* cases, *after* the application of retentive appliances; and this, perhaps, cannot be accomplished without some *special* mechanical contrivance in the splints, or otherwise. In fracture of the femur, displacement is apt to recur. Desault's or Liston's long *extending splint*, with a straight position of the limb, overcomes any such tendency; extension being effected by that portion of the bandage which passes round the foot-end of the splint, and counter-extension by a perineal band. Extension may be maintained by a *weight* slung from the extremity of the limb; as from the foot, in fracture of the femur attended with unusual tendency to displacement. But a heavy weight is unnecessary; three, four, or five pounds weight will suffice to tire the muscles and overcome their resistance. In certain

instances of fracture, extension is maintained by means of an adjoining *bone*, used as a lever. In fractured clavicle, the humerus is utilized; an axillary pad being the fulcrum. Counter-extension is also secured, occasionally, by means of an adjoining bone as the resting point. In fractured fibula, the head of the tibia is made the fixed point for Dupuytren's splint.

A suitable, yet simple, retentive apparatus, of splints and bandages, having been adjusted, the limb is rested and supported in a moderately *elevated position* to relieve any tendency to congestion, provided such elevation be compatible with that position whereby the muscles are most relaxed. In fractures of the lower extremity, where the patient remains in bed, a firm mattress is required to support the limb evenly and equably throughout its extent. If the fractured *part* be unsupported, it bends somewhat by its own weight, and displacement with eventual deformity will ensue. If either *end* of the limb be allowed to sink, there is the same tendency. Moreover, an *even* support to the whole limb is the best safeguard against sloughing from undue pressure on any one point. The weight of bed-clothes, if tending to disturb the fracture, may be removed by a *cradle.* Spasmodic action of the muscles continues, in most cases, only for the first few days after the fracture has been set, during which period, therefore, displacement is most apt to recur; but as the process of reparation scarcely begins before ten days or more—the "brooding-time"—has elapsed, the *final* adjustment of any displacement is comparatively unimportant until *then.*

The reparative lymph forms a soft callus, fibro-cellular or cartilaginous, which remains *pliant* for some days or weeks; and, as proceeding from the living bone, it is self-constructive, and adapting in its supply; differing in all these provisions from the sudden and passive setting of any inorganic concrete or cement, and which is without increment, in any artificial mode of adhesion. During the process of reparation, therefore, the pathological Surgeon is ever watchful, never meddlesome, in his regard to the correct coaptation of the fragments, and the consequent length and shape of the limb. *Absolute* rest of the fractured part is not essential to union without displacement; and this suggestion of pathology regulates the degree of security requisite in any form of artificially retentive apparatus. Every *trivial* displacement, also, of the splints and bandages need not be readjusted. If, however, the bandages slacken, they must be reapplied; if the retentive appliances get disarranged, they must be replaced. On the other hand, if *pressure* has become undue at any part, whether by swelling of the flesh or setting of the padding, that part should forthwith be relieved—perhaps by snipping the bandage, here or there, with fine-pointed scissors—ever remembering that the Surgical purpose of any "retentive apparatus" is not to fix the limb in a vice; but only so as, by securing rest, to gain time for the injured part to itself undergo the process of reparation.

If, therefore, spasmodic muscular action still recurs, from time to time, and threatens to frustrate the healing operation of Nature, the rebellious muscles should be coaxed, if possible—not coerced—by any acceptable alteration of position; and quieted by the administration of sedative medicines, of which opium and the tincture of digitalis are, perhaps, the most antispasmodic. Tenotomy has been proposed, as a last

resource, in the most obstinate cases; and division of the tendo-Achillis has been practised with success, in fractures of the leg.

At length the proper time arrives, when splints and bandages may be exchanged for an "immovable apparatus." When all chance of swelling has passed, spasm has ceased, and soft union is established, *then* only is the "starched" bandage *safe* and *advantageous.* At an earlier period, the unyielding nature of a solid casement would not allow for *any* alteration whatever in the size of the limb. As swelling inevitably supervenes, the immovable apparatus tightens, even to strangulation, and when the limb shrinks, it becomes as much loosened; thus entailing an almost daily entire reapplication of the apparatus, at that period of fracture. The unyielding nature of the starched bandage is offensive also to the muscles about the fracture, at a time when they are most irritable and susceptible of spasm. Professor Erichsen, I observe, advocates the use of a starched bandage at almost the *earliest* possible period after fracture, urging its safety and advantage, chiefly on these grounds: that it takes the shape of the limb "accurately and readily," and retains this shape by virtue of its "solidity." But these very characters of the starched bandage are, in my opinion, the most obvious and valid objections to its application at that time. I am accustomed thus to fix the limb immovably, only when it no longer needs watchful supervision; and such apparently was Erichsen's rule of practice formerly.

The construction of the starched bandage, and other kinds of immovable apparatus, for fracture, should be well understood. By no means a recent invention; albumen and flour, mixed, were used by Cowper, to stiffen fracture-bandages. Powdered chalk was preferred by Lawrence; dextrine, by Velpeau. Gum arabic, with whiting, is the mixture recommended by Smee. Gum-shellac, with glue, has also been employed. Plaster-of-Paris, by Mathieson and Van der Loo, of Holland; also by Kluge, of Berlin, and Pirogoff, of St. Petersburg. Starch was introduced by Baron Seutin, in 1834. A layer of cotton wool having been wrapped round the limb, and more thickly over bony prominences, short splints of softened pasteboard are adjusted around the seat of fracture; and, over all, a roller is applied in the ordinary manner, beginning from below upwards. A second roller is then applied, and the whole limb, thus encased, is smeared over with thick starch, which is worked in with the hands. A third roller may be used, if necessary, as additional security. The casement formed, dries firmly in a day or two. (Fig. 194.) Plaster-of-Paris has only one mechanical advantage; it dries, and sets in a few minutes. This forms the most rigidly immovable apparatus, and is especially serviceable when the patient must undergo a journey. But it is much heavier, and apt to crack behind a joint, as the knee. Supported by a starched bandage, the patient can move

FIG. 194.

about at a much earlier period than otherwise; a great advantage in relation to the general health, as compared with the prolonged confinement endured in the treatment of Fracture formerly.

No *medicinal* treatment or scarcely any of a constitutional character is, usually, required in the course of simple Fracture. The shock of injury having passed off, the healing process goes on without apparently troubling the general functions of the body; and they, in turn, take little or no notice of the local process. If all the local circumstances of the part itself be conducive to healing, and the individual be in good constitutional health at the time of the accident, it is then as natural for a fractured bone to heal and restore itself, as to maintain its own healthy integrity of structure by nutrition. *Diet* should be adapted to the altered hygienic condition of the individual, now disabled for business or pleasure; and, more particularly, it should be proportioned to the wants of reparation. At first, therefore, moderate and comparatively innutritious, the diet must soon be more liberal and nutritious. Mild aperients, just to regulate the bowels, are needed not unfrequently, when the patient is confined to bed; but active purgatives are, by their action, apt to occasion disturbance of the fractured part, and so peril the process of union.

In due time—a period varying considerably, according to the age and health of the individual—any retentive appliance may be *finally* removed with safety. The fracture must then be gently tried, to test its solidity, by passive motion of the limb. If firm union has taken place, the functions of the limb should be as tentatively resumed. In fracture of the lower extremity, this trial of power should be made *very* gradually; for, if worked too soon, the limb shortens under the weight of the body, and permanent crippling is the result. Œdema, in some degree, is inevitable, when first the limb is allowed to be free and pendant. Gentle frictions will aid in restoring the circulation; and a lightly applied bandage gives support to the flesh, as yet flabby. Prolonged confinement, however, would tend to permanently waste and weaken the limb.

Thus—as in the management of an incised wound—the artificial support of a fracture is gradually withdrawn, and the limb allowed to resume its functions as gradually; until at length unaided Nature can stand alone.

COMPOUND FRACTURE.—*Structural Condition, and Diagnostic Characters.*—Compound Fracture is, essentially, Fracture, with a wound in the skin communicating; thus exposing the seat of fracture, however indirectly, to the action of the air. (See Fig. 197.) The structural disorganization, as regards the state of the bone, is the same as in simple fracture; but compound fracture is usually accompanied with more severe contusion or laceration of the surrounding soft textures. This condition, coupled with that of the aperture externally, which is also contused or lacerated, together form a Contused or Lacerated Wound, connected with, and around, a Fracture.

The *Signs* of this injury are the same as those of simple fracture, with the additional and distinctive character of an external irregular wound. Therefore, both the condition and characters are those of simple Fracture, *plus* those of contused or lacerated Wound.

Causes, and Effects of Compound Fracture.—Here again, the pathological history is that of simple fracture, with certain peculiarities super-

added. External violence is generally the cause of the wound in the skin and subjacent soft parts, as well as of the connected fracture; which may then be regarded as produced by an extension of the injury from *without.* Or the fractured bone may itself penetrate to the surface and through the skin; the wound then being an extension of the injury from *within.* In the one case, the force is applied directly to the seat of fracture, and the injury is more a contusion; in the other case, the force is applied indirectly, to the bone at some distance off, and the injury is more a laceration, and less extensive. In both cases, the contused or lacerated textures are damaged beyond the apparent extent of injury; and the shock to the nervous system is more severe than with simple fracture, owing to the greater damage to the soft parts, including nerves. Tetanus is, perhaps, more apt to supervene than after a contused or lacerated wound alone, and especially if the compound fracture be oblique, and movable among nerves and muscles. The textures injured, being in a state of disintegration, die, at least to some extent around; if the wound be allowed to remain open. This purely *traumatic* gangrene is the same as that caused by a contused or lacerated wound. Limited, therefore, to the part injured, and defined, eventually, by sloughing, or by a line of demarcation between the living and dead textures, the gangrene is immediate also, if the injury itself be severe.

Course, and Termination.—Inflammation supervenes, followed by suppuration, perhaps profuse, and partial sloughing; or by gangrene, on a larger scale. Either degree of mortification, arising from inflammation, is limited to the seat of injury. By this process, however, a fracture, which originally was simple, may become compound in some cases. *Spreading* gangrene—due to some morbid condition of the blood—supervenes on compound fracture, only as an occasional contingency; and its phenomena have been already described in connection with the course of contused and lacerated wounds.

But the tendency of compound fracture, when reduced, is to undergo *reparation;* union of the fragments taking place, either through the medium of dense connective or fibrous tissue—an imperfect support, or through a bony callus, with firm consolidation, as in simple fracture. The wound in the soft textures closes up and heals by suppurative granulation and cicatrization. Under other circumstances, union of the fracture is effected by ossifying granulations. Thus, if the bone, when reduced, be exposed, in an open suppurating wound—say, the fractured ends of the tibia—granulations may form on either end, and meeting together, coalesce, constituting a soft callus, which becomes ossified. When a portion of the bone dies, whether as the result of contusion or comminution, or having been laid bare by sloughing, or isolated by burrowing suppuration around the bone, the dead portion is slowly detached, by the process described in connection with *Necrosis,*—the detached piece being named an exfoliation, or a sequestrum; then, the subjacent granulations springing up more freely, form the callus, which is transformed into new bone. (Fig. 195.) The *histological* process by which bone produces granulations, consists of the following changes, as demonstrated on or in a denuded portion of bone, *e.g.*, the tibia. At about the end of ten days the bone, which had hitherto a yellowish colour, assumes a bright red tint, having become more vascular. The surface is beset with a number of red

points, or little streaks; they are the young granulations, which rapidly growing in height and breadth, spread and coalesce, so as to present a mamillated granulating surface, continuous with the granulations of the surrounding soft textures. Thus far the process may be traced by the eye, aided only by a lens, in the early stage of vascular pointing. But an injected specimen of such bone, deprived of its inorganic matter, shows certain changes in the osseous texture, which are disclosed by microscopic examination. (Fig. 196.) The Haversian canals are crowded

FIG. 195.*

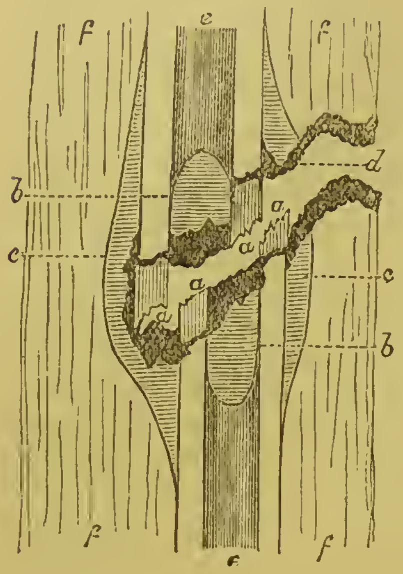


FIG. 196.†

with small round cells—apparently emigrated white blood-cells—which infiltrate the connective tissue along the walls of the canals, and the included blood-vessels have developed into vascular loops; this infiltrated tissue, together with the looped vessels, growing to the surface of the bone, sprout out of the open ends of the osseous canals, in the minutely punctiform appearance of the young granulations. The canals themselves at first become atrophied and enlarged, by absorption of their walls, to make room for the cell-infiltration, and thus the granulating bone appears porous, when macerated to remove the out-cropping granulations. Ossification of the granulation-tissue proceeds rapidly within the bone, so that the osseous texture soon loses its porous character, and becomes denser and harder from the interstitial deposit of new bone. Between the fractured ends, ossification takes place far more slowly, leaving the callus a soft, fibrous connective-tissue bond of union, for perhaps a long period; while, on the surface of a bone, granulations acquire only the character of a condensed texture, in a cicatrix which, although continuous with the surrounding skin, is firmly attached to the subjacent bone. *Diffuse suppurative periostitis* and *osteomyelitis*, or diffuse suppuration within the medullary canal and cancellated structure of a long bone, may both

* Diagram showing fracture of a long bone with external wound, *i.e.*, compound fracture, in a longitudinal section.—*a*, necrosed ends of bone; *b*, internal callus; *c*, external callus; the darkly shaded granulations are continuous with the external wound, *d*; *e*, ends of bone, displaced; *f*, surrounding soft parts. Natural size. (Billroth.)

† Diagram showing detachment of a necrosed portion of bone; similar to sloughing in a contused wound. The upper or dead portion is detached from the lower or living portion of bone, by cell-infiltration between the two portions and into the adjoining Haversian canals. 300 diam. (Billroth.)

be mentioned as causes of necrosis in compound fracture. But the necrosis will probably then be so extensive—the whole shaft of the bone perhaps perishing—that these diseased conditions have no practical relation to the union of compound fracture.

The *average period* for union in compound fracture is about twice as long as in simple fracture. Thus, with regard to a long bone, and in the lower extremity, as the tibia, three or four months may elapse ere the same degree of firm ossific-union is produced. In the event of union being effected by granulation, the process is more prolonged; just as in the soft textures, this mode of healing is slower than primary adhesion; and osseous granulations are produced even more slowly than granulations in the soft textures. When the process is complicated by necrosis, the previous detachment of the dead portion of bone delays the union to the longest period.

Ununited fracture, and false-joint, will be hereafter considered.

The *Prognosis* of compound fracture, as gathered from a due consideration of the natural course and tendency of this lesion, is far less favourable than that of simple fracture. An *open* wound, communicating with the seat of fracture, as compared with subcutaneous laceration of the soft parts, is one unfavourable ground of prognostic distinction. Scarcely less so is the *greater extent* of their laceration, usually in compound fracture; especially if produced by direct violence. Consequently, the chequered histories of hæmorrhage, shock, and tetanus; traumatic gangrene, inflammation, and its consequences, in suppuration and sloughing; necrosis; erysipelas, and pyæmia; have each and all to be taken into account, as being more or less probable contingencies in considering our prognosis of compound fracture. *Spreading* gangrene is an adventitious condition, yet a most unfavourable one, as implying the co-operation of a constitutional cause.

The following results of compound fracture are practically interesting and important for reference, as exhibiting the *relative frequency* of such fracture in either limb, and in different parts, their comparative *mortality*, and the *causes* of death; according to Mr. Bryant's analysis of 302 cases in Guy's Hospital, during a period of twenty years. (Med. Chir. Trans. vol. xliv.)

Of the whole number—302 cases—

17, or 5·6	per cent.,	were of	the thigh.
193, or 63·9	,,	,,	leg.
35, or 11·5	,,	,,	arm.
57, or 18·8	,,	,,	forearm.

In the *thigh*, 11 of the 17 cases were fatal, or 64·7 per cent.; in the *leg*, 74 of the 193 cases were fatal, or 38·3 per cent.; in the *arm*, 4 of the 35 cases died, or 11·4 per cent.; in the *forearm*, 7 of the 57 cases died, or 12·2 per cent. In the *whole* number of 302 cases, 96 were fatal, or 31·7 per cent.

The *causes* of death were—exhaustion, gangrene, pyæmia, delirium tremens, bronchitis, tetanus, secondary hæmorrhage, internal complications, erysipelas. As to the relative frequency of these various causes, it would appear that the two first named, exhaustion and gangrene, were the most common,—amounting respectively to 40·6 per cent., and 11·4 per cent. Pyæmia amounted to 21·8 per cent., but this high mortality depended on amputation; pyæmia being twice as fatal in those subjected to operation, *i.e.*, 27·7 per cent., against 14·2 without

amputation. On the other hand, in attempting to save the limb, delirium tremens and tetanus were the common causes of a fatal result. Accidental causes, such as bronchitis, need not be taken into account.

Treatment.—The same rules of treatment are applicable as for simple fracture; but certain particulars, having reference to the special pathology of compound fracture, are peculiar to its treatment.

Reduction of the displacement may present special difficulties. Thus, if one or both ends of bone *protrude*—whether this condition was produced by the original force of the fracture, or by the sheer weight and position of the limb, or possibly by rough handling—the displacement can be reduced by sufficient extension of the limb. When, however, such displacement is due rather to muscular contraction and spasm, acting especially on the lower fragment, which is thus drawn upward; enlargement of the wound, by incision, will be preferable to forcible extension; and this proceeding is the more urgent also, in proportion to the circumferential swelling, from hæmorrhage or serous effusion. With increasing tension, the protruded portion of bone becomes tightly embraced by the aperture in the integuments, through which it has passed; a condition not unfrequently witnessed in compound fracture of the tibia, and which obviously suggests the propriety of enlarging the aperture to free the bone. Exceptional cases sometimes occur. When protrusion arises from *deformity* of the bone, as in rickets, excision of a portion of the bone may then be necessary to reduce the displacement. Union, firm and permanent union, will probably take place, with, or without, the reproduction of new bone as an intermediate callus. The limb is ultimately restored to its original length, or remains proportionately shorter than its fellow. In one such case, where the tibia was arched forward, in consequence of rickets, I removed two inches of that bone, an inch from either fractured end; and the result was highly satisfactory. When, more rarely, the protruded portion, although reduced, cannot be kept in place; it may then be advisable to excise that portion to a sufficient extent for this purpose. But the difficulty can generally be overcome by an altered position of the limb, or by tenotomy; as when the lower end of the tibia is tilted forward by traction on the tendo-Achillis. *Splinters* of bone have special significance in relation to the treatment of compound fracture, there being an open wound communicating. If only partially detached, any such portion of bone may retain its vitality and regain its connection. But if completely detached, the fragment is obviously a foreign body, and should be removed; a proceeding the more imperative, when any such fragment intervenes between the fractured ends of bone; thus opposing their reduction and intercepting their subsequent apposition, and the process of reparative union. In any case, where a considerable portion of bone is removed in compound fracture, whether owing to protrusion, deformity, or splintering, care should be taken, in maintaining reduction, that the interval between the ends of bone be not equal to the portion removed; lest, an inadequate length of callus being produced, imperfect union should be the result.

The Wound.—Reduction-difficulties having been overcome, and the limb retained in position by suitable splints, well padded and protected by oiled-silk from the soaking of any discharge issuing from the wound: then comes the treatment of the wound itself, and state of the soft parts involved. The *primary* indication is to close the wound, with the view

of soliciting its union by adhesion, and thus convert the fracture into a simple one. For this purpose, a pad of wet lint, or soaked in carbolic-acid solution, should be applied over and around the wound, so as entirely to exclude the air.

Considering the great difference, in safety and time, between primary adhesion and the process of suppurative granulation, assuredly the former mode of reparation should be first solicited in *all* cases. In some compound fractures, with comparatively little laceration of the soft textures and of the aperture externally, as when produced indirectly, by protrusion of the bone, the wound being closed and protected from the air, heals by adhesion in a few days, and the subsequent progress of the case is that of simple fracture. In other cases, with contusion of the wound and subjacent textures, this mode of healing may be *tried*, in the *first* instance; but it should be abandoned immediately effusion and tension supervene in any such degree as clearly indicates the necessity for a free discharge of clots, and of matter during the course of suppuration. *Early* solicitation of primary adhesion, and *timely* abandonment of the attempt, in favour of suppuration, as soon as this event occurs or is inevitable, constitute a compromise, which overrules any objection as to the *probable* failure of the one and the supervention of the other. If the attempt prove successful, the advantage is gained of then having to deal with only a *simple* fracture. Displacement, occurring during the healing of the wound, might tempt the Surgeon to rectify it; but the safer practice will be, to wait until this can be done without destroying the granulations, whereby probably the most intense inflammation would be provoked, and the fracture be made, or become, again compound.

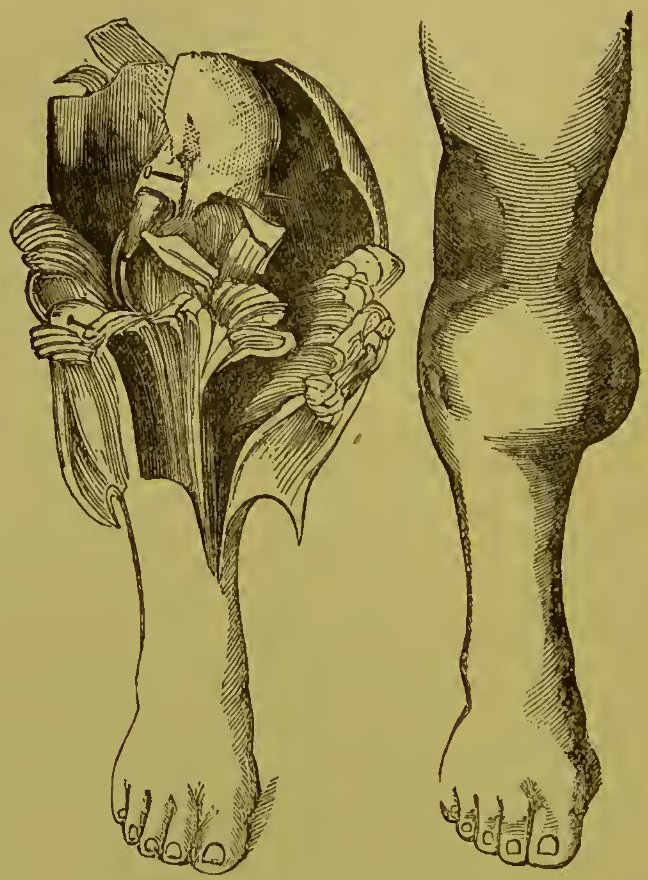
Suppuration, or *Gangrene*, having supervened, the treatment should respond to these consequences of Inflammation. Firstly, as regards *local* measures. With progressive suppuration, pus may be diffused and accumulate, without much, if any, tendency to point; then, *early*, *free*, and *dependent incisions* are necessary, for the easy vent of matter as it forms, and to relieve tension. Otherwise, the pent-up matter, working its way about the seat of fracture and among the textures around, dissects and detaches the bone, periosteum, muscles, nerves, and vessels; and thus destroying their continuity, the fracture remains ununited, and the parts around become saturated and soddened; in short, an irreparably disorganized limb is the result. Consequently, at a later period, incision may be necessary to remove any portion of dead bone, whether as an *exfoliation* or a *sequestrum*. Compresses of lint, properly applied, will do much to prevent the burrowing of matter; and the pad of wet lint, which closed the wound in the first instance, may now be advantageously exchanged for a poultice, or piece of wet spongio-piline, as a cleaner application, to promote the discharge, for a time. But this should be succeeded by light water-dressing, or with carbolic-acid solution, when the continuance of warmth with moisture would only sodden and relax, and when the wound is granulating.

Hectic fever and exhaustion, consequent on prolonged and perchance profuse suppurative discharge, are best relieved by a diet, consisting principally of animal food, in which albuminoid matters prevail, with wine, beer, or spirits, according to the patient's previous habits. In short, what is termed a nourishing and stimulating diet is most efficacious; the quantity of food being regulated by the digestive

power of the individual, and the stimulants proportionate to his previous habits and present exhaustion. Tonics, in the shape of quinine and the diluted nitro-muriatic acid, or other mineral acid, are to be regarded only as serviceable adjuncts. Sleep must be procured by an opiate nightly, when necessary; and restlessness allayed by maintaining the influence of opium, slightly, day by day, until the strength is somewhat restored. Careful regulation of the alvine evacuations is a most important injunction throughout the course of hectic fever; any approach to constipation increasing the general irritability. It may, however, often become necessary to check, if possible, the tendency eventually to diarrhœa. The hygienic and medical treatment for the *typhoid fever* arising from gangrene or sloughing, is substantially the same as that for hectic fever.

Amputation.—The question of amputation in compound fracture

FIG. 197.



turns upon the probability as to the supervention of traumatic gangrene, or of profuse suppuration, with perhaps necrosis; in either way, the limb will be *irreparably* disorganized, and life thereby endangered.

(1.) When the *whole substance* of a limb is involved by the injury of compound fracture, either or both results are *inevitable;* and there is no alternative but *primary*, or immediate, amputation.

Such was the condition in a case of *compound* and *comminuted fracture* of the *tibia*, just below the anterior tubercle, with *fracture* of the *fibula*, one inch below the head of that bone. (Fig. 197, showing

appearances on removal of integuments.) But there was also (as represented) extensive *laceration* of the *muscles*, particularly of the tibialis anticus muscle, which was torn across and thrown inwards over the tibia; the *anterior tibial artery* was torn through (as indicated by the lower pin in the figure), but the corresponding nerve and the musculo-cutaneous nerve (seen above) were entire. Here, then, in addition to the worst kind of fracture of both bones, the conditions were present of inevitably profuse suppuration, by extensive laceration of the muscles, and of impending gangrene, by rupture of the anterior main artery. This injury was caused by contusion of the leg between a brewer's dray and a post, and I may add, therefore, another lesion had occurred—*extensive detachment* of the *skin* from the deep fascia of the limb, the superficial, cellular, or subcutaneous fascia being infiltrated with blood. It corresponded to the large sheath of integument thrown back in the figure. This condition I have found also in the dissection of many other limbs severely injured by direct violence. It may be present without any wound in the skin, or discolouration at first, and it may exist far beyond the apparent seat of injury, thus misleading the Surgeon as to the *part* proper for amputation. The characteristic external appearance of this *typical* example of bad compound fracture is represented in the adjoining figure of the limb, as seen within a quarter of an hour after the accident. The swelling, of considerable size, corresponded to the lacerated and blood-engorged extensor muscles, and their displacement inwards over the tibia. Four apertures in the skin, the two upper communicating directly with the fracture, complete the picture.

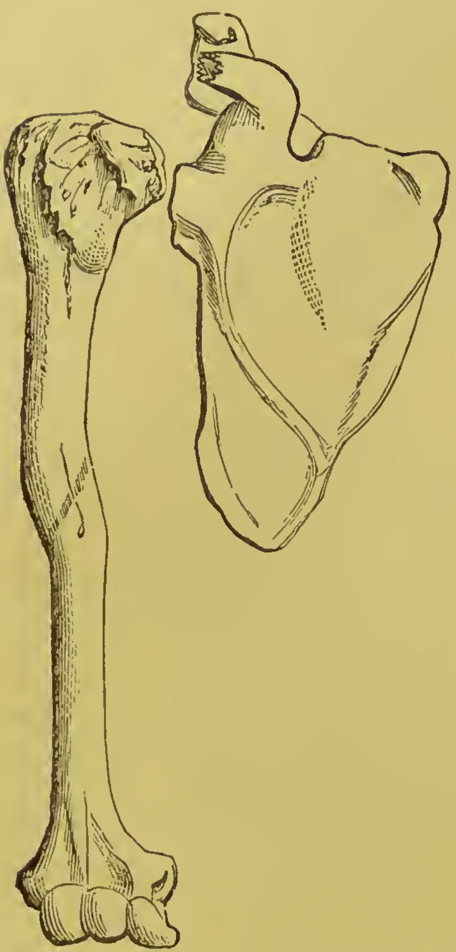
(2.) When, however, the extent of damage is itself *partial*, the supervention of gangrene or of profuse suppuration is but *proportionately probable;* the limb is *not* inevitably lost, nor the life surely perilled. Accordingly, the postponement of amputation until the *actual supervention* of either or both these local conditions—in other words, *secondary* amputation—should be the rule observed, in order to give the limb *its* chance of preservation; the safety of life being provided for by *timely* amputation, under these circumstances.

The question of amputation, and as primarily or secondarily, is determined by these pathological considerations.

Certain rules, however, as to the urgency of amputation are laid down in surgical works, according to the *extent* of injury to the vessels, nerves, etc. Any such pathologico-anatomical conditions have significance only in proportion to the certainty or probability of gangrene or profuse suppuration supervening. I here omit the probabilities of secondary hæmorrhage, exhaustion from shock, the occurrence of tetanus, erysipelas, or pyæmia, as being contingencies which cannot be foretold, and some of which are preventible. But observations of the course and tendency of compound fracture, in different doubtful cases of the other class, have not hitherto been sufficiently accurate and ample, to establish any such absolute rules of practice with respect to amputation; and less so when the necessarily unknown capabilities of the reparative power in different individuals are also taken into account. No Surgeon can positively determine whether amputation should be performed in a doubtful case; guided by this or that particular extent of injury, and in this or that individual; at different periods of life also, from youth to age; and as subject to the modifying

influence of previous habits. Misled by *à priori* considerations suggested by the pathologico-anatomical conditions of compound fracture, clinical observation is precluded; and thus many limbs are probably sacrificed surgically, which otherwise might be saved, if the treatment were determined by watching the actual course and tendency of the case; in other words, by observing the vital career of the particular form of injury, and as subject to the reparative power of the individual. Not one of the conditions of compound fracture, alluded to, are found to be invariably followed by profuse suppuration or gangrene; not one of the considerations commonly urged in surgical works, as to the necessity for primary amputation, are infallible. If, then, *exceptional* cases are discovered by the advancing study of living conditions, in how many more cases might limbs, hitherto sacrificed surgically, have been saved, and be preserved in future?

Fig. 198.*



Spreading traumatic gangrene, arising from compound fracture, has the same relation to amputation, as in the case of contused or lacerated wound. The rule of treatment should be: removal of the exciting cause by amputation of the limb, without delay, and at some height above the seat of fracture—no line of demarcation forming in spreading gangrene, to indicate the time and part for amputation.

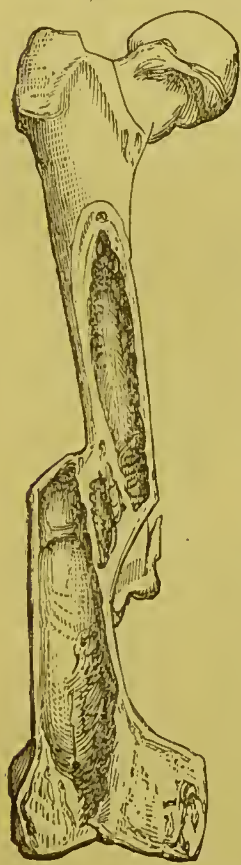
Complicated Fractures.—These injuries follow naturally in the order of description after compound Fractures, which is a complication relatively to the simple form of this injury. But the complications here referred to are *any additional* injury or injuries which may be received simultaneously with Fracture, whether itself simple or compound; and *any morbid condition*, local or constitutional, which may be

* St. Bartholomew's Hospital, C. 79. In the valuable specimen from which the drawing for this figure was taken, the head of the humerus was dislocated upwards and backwards upon the dorsum of the scapula,—a rare form of dislocation; but, being unreduced, the formation of a new joint is even more peculiar. The margin of the head rested, in a hollow, against the inferior surface and the outer edge of the spine of the scapula; while the neck of the humerus moving upon and across the inferior half of the glenoid cavity and the adjoining part of the lower border of the scapula, this part of that bone has become broad and convex, and that of the humerus is deeply grooved for its reception. The surfaces of the bones in the new joint are accurately adapted, and highly polished. A fracture through the middle of the shaft of the humerus is firmly united, but with some angular deformity.

connected with either lesion as predisposing to its recurrence, or as affecting the process of its repair.

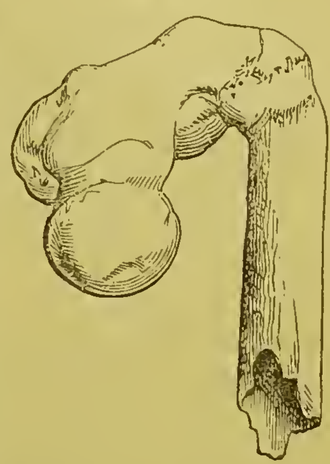
Fracture may be complicated by association with *injury* to a *large artery* or *nerve*, by extensive laceration of the *muscles*, by extending into a *joint*, or by an accompanying *dislocation*. (Fig. 198.) It may be associated also with injury to some special part or *internal organ;* as fracture of the pelvis implicating the bladder, of the ribs wounding the lung or pericardium, or of the skull injuring the brain. Then again, Fracture may be complicated by association with some *morbid condition*, local or constitutional. Thus, certain blood-diseases predispose to Fracture, and retard or arrest the formation of callus. Rickets, syphilis, cancer, scrofula, and scurvy, have severally this twofold effect; while febrile disturbance, erysipelas, starvation, and perhaps pregnancy, severely tend to prevent union.

FIG. 199.



Treatment.—Two pathological considerations are of general practical importance and applicability, in relation to the treatment of the various complications of Fracture—simple or compound. 1stly, Is the complication any *morbid condition* or *conditions* in operation, locally or constitutionally, which affect unfavourably the natural process of repair? In this case, the treatment must be entirely subject to such one or more conditions. 2ndly, Is the complication any *injury* or *injuries*, *additional* to Fracture? In this case, the treatment of the *fracture* may be of entire subordinate importance, even although it be, as in many such cases, severely compound.

FIG. 200.



DISEASED CALLUS, AND DEFORMED UNION.—These conditions represent the unfavourable terminations of United Fracture.

The whole pathology of Diseased Callus is that of Diseases of Bone in general; but they may severally be associated with Deformed Union after Fracture.

Structural Conditions.—Deformed Union of Fracture appears in various shapes, according to the relative position of the fragments. (*a.*) Union with displacement; angular, rotatory, or transverse, with overlapping of the fragments; and oblique or longitudinal displacements. (Fig. 199.) The most singular and extreme degree of deformity resulting from the union of fracture I ever met with, is here shown. (Fig. 200.) The shaft of the femur is united at an angle of 75°. In the other thigh of the same person, a fracture had united at the same angle. Both specimens are in the rich collection of the Museum of St. Bartholomew's Hospital. (*b.*) Union of two adjoining parallel

bones, as the radius and ulna, the tibia and fibula, or two adjacent ribs.

Diagnostic Signs.—These various conditions of deformed union present obviously characteristic appearances; but they resemble the appearances produced by corresponding displacements in Fracture without union. Absence of mobility will always be distinctive of deformed *union.*

Causes, and Effects of Deformity.—The *external* causes of deformed union after Fracture may be any circumstances which occasion displacement of the fragments. Thus, unsuitable retentive appliances, or their unsuitable application, will have this effect; so also, rough handling of the part, during the process of repair. *Internal* causes comprise muscular action displacing the fragments, and *diseased* conditions of the callus; as exuberant callus, resulting from inflammation affecting it during, or after, its formation.

The *effects* of deformed union of Fracture are *mechanical.* If occurring in the neighbourhood of a joint, its action will be impaired. If in the shaft of a long bone, as the femur, ineffectual power is experienced, and in various ways, according to the direction of displacement. Thus, shortening of the limb occasions lameness. If two companion bones are conjoined, serious loss of function may be the result; as loss of pronation and supination of the forearm by union of the radius and ulna. Or such union may be unimportant; as in the case of the tibia and fibula.

Terminations.—In respect to the process of union, the vital history of deformed union presents nothing peculiar. The recognition of two stages in the process is, however, of practical importance; recent or *incomplete* ossification of the callus, and old-standing or *complete* union.

Treatment.—(*a.*) *Recent* union, with displacement, suggests the propriety of endeavouring to rectify the deformity *gradually. Infraction,* by extension or bending, and compression, may be applied; either by manipulation, from time to time, and the interim application of a suitable retentive apparatus, or by means of some contrivance to slowly reduce the displacement. Either should be worn as long as occasion requires; say, from 3 to 5 weeks. Successful results have been obtained in numerous fractures after union of some duration; as 25, 29, 59 days; and, possibly, after 4 or 5 months. Thus, I succeeded in straightening the forearm by manipulation, in the case of a child, where fracture of both bones had joined at an angle backwards; a tolerably firm callus having formed. The arm became completely useful, in all its movements. In the event of a *more* unyielding callus, although still of recent formation, *refracture* becomes necessary; but this must be done cautiously. It may be accomplished in like manner —by manipulation, or by the application of a screw-press; in either way, the object being to break the callus, under the influence of chloroform, and to reset the bone in its natural axis and position. The extreme period of union when this procedure can be safely resorted to, is determined principally by the *degree* of consolidation which may have taken place. *Experience* has sanctioned different periods of limitation. Thus, the twenty-fourth week is the extreme limit advisable, according to Osterlen. A little longer was conceded by Bosch, perhaps 6 or 6½ months. Mr. Skey, however, in one case

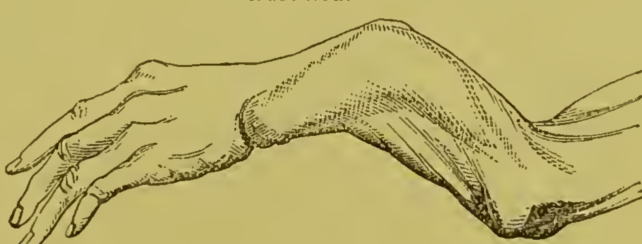
refractured the leg of a boy, ætat. fifteen, 13 months after the original fracture.

(*b.*) *Complete* osseous-union can only be overcome by a *cutting* operation. The callus having been laid bare, it may be *divided*—the operation of *section*—by a small saw or bone-forceps; or *excision* of the callus may be necessary, particularly if it be exuberant. The ends of bone are then to be readjusted aright, and the case treated as compound fracture. But the very fact of this condition resulting from the operation, coupled with the inherent peril of the operation itself, renders it one not lightly to be entertained. To say that by an incision the callus is reached, does not convey a true idea of the operative difficulties then experienced, owing to various *pathological* conditions of the callus, and of the parts around.

For the inter-union of two *contiguous* bones, accompanied with serious loss of functional utility, as pronation and supination in the forearm, division of the callus is more imperatively necessary, if refracture cannot be accomplished. But with union of the tibia and fibula, either, and indeed any, operative proceeding is generally unimportant; and, as regards the junction of two ribs, is obviously impracticable.

UNUNITED FRACTURE, AND FALSE-JOINT.—DISUNITED FRACTURE.—*Structural Conditions.*—Four varieties of Ununited Fracture are recognized; two of which may be regarded as stages of non-union, and two of false-joint; in either case, proceeding from incomplete to complete. They thus form a continued series of structural conditions, from imperfect union to perfect articulation. (*a.*) The fractured ends

FIG. 201.*



of a bone may be united by an ensheathing *cartilaginous* callus; which, however, fails to undergo ossification. This condition is known by partial mobility of the part when handled, and the limb is proportionately useless. (*b.*) *Total* non-union may occur, there being no kind of connecting medium between the fractured ends, which are also apparently diminished in size. They are freely movable, and the limb is altogether useless and wasted. (*c.*) Most commonly, in both fragments, the medullary canal is obliterated, the ends are rounded and pointed by absorption, and covered in by the formation of a tissue resembling periosteum; they are connected together by a strong *ligamentous band*, or by several narrow bands, firmly attached to the bones. This new material is very pliable, and the *incomplete joint* thus constructed is movable according to the length and laxity of such ligamentous connection. (Fig. 201.) (*d.*) Lastly,

* Ligamentous union of both bones in forearm, after fracture; seven years date; the patient a man aged 80. Royal Free Hospital.

and rarely, a dense *capsular ligament* may be formed, and contain a fluid like synovia; the ends of bone have become smooth and polished, possibly eburnated, or covered with points—possibly thin plates—of cartilage, and a synovial membrane similar to that of a natural articulation. Thus, then, a *complete* false-joint is constructed. (Fig. 202.) The fractured ends, instead of being partially consolidated, as in the first condition, are freely movable; but they have not the *useless* mobility of total non-union, nor the irregular action allowed by a loose band or bands of ligament with intervals between them and which less entirely surround the ends of bone. They are retained *in situ* by a dense and complete capsule, and cannot be displaced unless subjected to considerable force. The limb is proportionately *useful*. Some Surgeons, such as Chelius and Hewson, supporting the assertion originally made by Boyer, have disputed the existence of this complete condition of false-joint. Several authentic cases are, however, recorded by Norris. Key saw an instance in the spinous process of a vertebra; Brodie, in a rib; Kuhnholtz, in the femur; Home, Cruveilhier, and Howship, in the humerus. Breschet readily produced complete false-joint, in his experiments on *animals*, in which it seems to be the most common form of union.

Fig. 202.*

Causes and Effects of Ununited Fracture.—The *external* causes of non-union after Fracture may be any circumstances which occasion motion of the fragments, beyond that degree which is compatible with the formation of callus and its ossific consolidation. Unsuitable retentive appliances will have this effect, or their unsuitable application; so also, handling the part daily or even more than occasionally, during the process of repair. Hence the practice sometimes witnessed, of frequently readjusting the limb, is as obnoxious as that which formerly prevailed, of close imprisonment and unalterably fixed position. *Internal* causes comprise—*muscular action* separating the fragments and thereby preventing union, as in fracture of the patella, and in that of the olecranon; or the interposition of any *foreign body*, whereby union may be intercepted. A portion of muscle, tendon, or a clot of blood intervening, is thus obstructive; of which two instances, by a piece of muscle, were seen by Mr. S. Cooper. A fractured clavicle, however, has been known to unite by two pieces of bone which enclosed an ossified subclavius muscle. (Bérard.) A piece of dead bone, in another case, retarded the process of repair for eight months; when the sequestrum being removed, union ensued in three or four weeks. (Schmucker.) Other local internal causes—not acting mechanically as impediments to union—pertain to the function of *nutrition*, at the seat of fracture. They are, chiefly, a deficient supply of blood to one of the fragments, as to the head of the femur, or of the humerus, in intra-capsular fracture of either of these bones; or both fragments may be ill-nourished, as after the main artery of a limb has been ligatured; any obstruction to the circulation, producing local anæmia, as by

* False-joint in the tibia. King's Coll. Hosp. Mus., 1181.

early, tight, or prolonged bandaging, or by an immovable apparatus; wet, and especially refrigerant applications; or, on the other hand, inflammation, an abscess, or ulcer; paralysis, or any occasion of pressure on the nerves distributed to the seat of fracture; and lastly, disease of the bone itself. But the latter causative condition is not unfrequently a local manifestation of some blood-disease as a constitutional cause, and affecting the *quality* of the blood supplied to the part.

The influence of *blood-diseases* in preventing or retarding the formation of callus, has already been noticed among the complications of Fracture. The diseases alluded to are, chiefly, rickets, syphilis, cancer, scrofula, scurvy, fever, erysipelas, and the conditions of blood consequent on starvation and pregnancy. But opinions are, as I have said, divided respecting the alleged mal-influence of these diseases. The same adverse character is attributed also to habitual intemperance, copious hæmorrhage, or other discharges; and, in short, whatever induces general enervation of the vascular and nervous systems with failure of nutrition. One or more of such causes may, however, exist without preventing or retarding the process of osseous union and firm consolidation.

The *effects* of ununited fracture are entirely local and mechanical, by impairing the action of the muscles and the use of the part. The limb becomes wasted, powerless, and useless; and the more so as non-union is complete and permanent.

Terminations.—Ununited Fracture frequently proceeds to a natural cure. In case (*a*), this takes place by *ossification* of the cartilaginous callus, already formed, which then becomes an instance merely of retarded or delayed union. The line of distinction between *arrest* and *delay*, in the transformation of a cartilaginous into an ossific callus, is imperceptible, and therefore doubtful, in all cases. Experience shows that not until after four, six, or even eight months have elapsed, is firm union by unaided Nature eventually improbable. In case (*b*)—that of total non-union—the process of natural cure may supervene by the *formation* of a uniting medium, and its ossific consolidation.

But Ununited Fracture may remain in a *stationary* condition; the process of union being arrested, in either of the cases, (*a*) or (*b*). Lastly, the Fracture may become *more movable* by the formation of a false-joint; incompletely (*c*), or completely (*d*), as a diarthrodial false-joint.

In estimating the probability of either of the latter issues, statistical results are at least trustworthy to show the comparative infrequency of non-union, in *any* form, as the *final* issue of Fracture.

Amesbury seems to have believed in the frequency of non-union. His experience extended to 90 cases. But Walker, of Oxford, affirms that of not less than 1000 fractures which came under his treatment at some period of the repair, he does not recollect more than 6 or 8 instances. According to Lonsdale, not more than 5 or 6 cases of false-joint, excepting those within a capsule, occurred in nearly 4000 fractures treated at the Middlesex Hospital. In a table of 367 cases, collected and arranged by Mr. W. Morland from the books of the Massachusetts General Hospital, extending through a period of nineteen years, only one instance of false-joint is recorded; and as only

seventy-four days had elapsed when this patient was discharged, it is doubtful whether this might not have proved to be a case of delayed union simply. Of 946 cases of recent fracture in the Pennsylvania Hospital, between the years 1830 and 1840, no instance of false union followed the treatment pursued. Sir Stephen Hammick, Liston, and Malgaigne bear testimony also to the infrequency of these accidents in the cases which have come under their care. Hamilton has seen a considerable number of examples of non-union, but in not one of his own cases, whether in Hospital or private practice, has the bone refused finally to unite ; and his opinion is that, in proportion to the total number of fractures which occur, such cases are very rare, perhaps not more than 1 in 500. In my own experience, I may add, 6 cases only have come under my observation or treatment; as compared with many hundreds of fractures, during a period of nearly twenty-five years. Two were fractures of the humerus, at the junction of the middle and upper third; and two were fractures of the femur; one at about the junction of the middle and lower third, and the other at the junction of the middle and upper third. A compound and comminuted fracture of the tibia, about the middle of the shaft, was followed by the separation of portions of dead bone and incomplete or cartilaginous union. Lastly, the case of the forearm figured at p. 603.

Treatment.—Earliest occasion for interference.—Guided by the natural course and tendency of Ununited Fracture, not until the lapse of 4, 6, or even 8 months, is the Surgeon justified in concluding that union will not take place. During, however, the latter portion of this period, and even before the expiration of the first-named period, 4 months, he will begin to *suspect* the *improbability* of union ensuing; this improbability increasing according to the lapse of time, without the process of repair supervening, or adequately progressing. Consequently, the earliest occasion, or period for interference, is some months *before* the fracture assumes the condition of false-joint.

Indications of Treatment.—Taking the structural conditions in the order already mentioned, the indications of treatment have reference primarily to non-union, in each of the two states described.

(*a.*) With *incomplete* union, the general indication of *local* treatment is to encourage, or excite, the process of ossification in the cartilaginous callus, so as to complete the reparation. The fulfilment of this indication consists in the continued treatment of the case as one of fracture; namely, by the reapplication of retentive apparatus, observing to correct any error in its construction or adjustment, which allowed of undue mobility, obstructed the circulation of blood, or the supply of nervous influence. By thus insuring rest to the part, and the other local conditions that are essential for reparative nutrition, ossification may ensue. Hence, also, any topical application previously in use, which may have reduced the nutritive vitality of the part, must be discontinued. Inflammation, and its consequences, suggest indications of local treatment. Another general indication is to supply, if possible, any defective quality of blood referable to any of the *Blood-diseases*, which are severally known to exercise some degree of prejudicial influence on the ossification of callus. Phosphate of lime has been administered, or lime-water drank, for some weeks, but with little or no effect in promoting ossific deposit. Experience shows that a liberal proportion of animal food, with wine, beer, or spirits, according

to the patient's previous habits and present condition, constitute an efficacious diet; and that exercise daily in the open air proves specially beneficial. If the limb be encased in a starched bandage, and slung from the shoulder, the patient will be enabled to move about without interrupting the consolidation of the callus.

These precautionary and soliciting measures having failed, there is no alternative but to have recourse to some operative procedure. Various other manipulative proceedings have been proposed—*e.g.*, friction, or with stimulating embrocations, and the application of galvanism by electro-puncture of the soft callus; but no such measure has any known direct relation to the process of ossification; nor are their results sufficiently successful to justify the further postponement of operation.

Fig. 203.

The only question, therefore, is the *kind* of operation which may now be requisite. It should be remembered that a *callus* already exists, only in an unossified state. It would be unsurgical to undo what Nature has already so far accomplished, by any procedure of a destructive character.

Acupuncture, or *subcutaneous section*, of the cartilaginous callus has often had the desired effect of inducing ossification. Either operation is easily performed. The one by puncturing the callus in two or three places, with the view of starting as many centres of ossification; for which purpose Brainard's perforator, or the Archimedean drill (Fig. 203), being more handy, may be used. The instrument is introduced through the skin and subjacent integuments, and, having pierced the callus at one point, is reapplied at another point, and so on, without withdrawing it from the skin. The other operation is accomplished by dividing, or at least incising, the callus, subcutaneously, with a tenotomy bistoury, or a long narrow-bladed knife. In either proceeding, care must be taken, if possible, to avoid wounding any nerve or vessel of magnitude, adjacent to the callus, and to which it may be attached; and to at once close up the puncture, or the aperture, lest the fracture become permanently compound. Obviously, however, in proportion as either operation may have *this* tendency, or *that* liability, its propriety will be questionable.

The late Professor Miller reported five cases of ununited fracture thus treated successfully. The operation appears to have been a compromise between division and puncture; the callus having been freely *irritated* at several points with a small tenotomy bistoury. This practice was successfully imitated by Mr. G. F. Sandford, of Davenport, Iowa, in two cases; and others might be cited.

(*b.*) *Complete* non-union suggests the same treatment—local and general; and also the removal of any other local cause. Thus, an intervening piece of dead bone, or other mechanical impediment to union, may be removed. These remedial measures not succeeding, it will be advisable to remove the nearly lifeless and altogether ununited ends of bone. *Excision* is preferable to *scraping* or rasping, which, leaving the

ends in a somewhat contused state, is less favourable to healing. Both modes of operation convert the fracture into compound. Excision was first practised by White, of Manchester, in 1760, and it has since been attended with variable success in the hands of different Surgeons. Of 39 cases collected by Norris, in which the ends of bone were excised or rasped, 24 were successful, 7 remained ununited, and 6 were fatal.

Excision is, in my opinion, peculiarly appropriate where the ends of bone cannot be retained in apposition, owing to an *oblique* direction of the ununited fracture—a comparatively rare case; or to *deformity* of the bone, as from rickets. A successful case of this kind, in which I excised an inch of either end of bone, has already been referred to. In fracture, from, or with, *locally diseased* bone; in compound fracture, with protrusion and *contusion* of the fragments; and in all cases of fracture *completely* and *persistently* ununited; excision is specially indicated, and may be practised successfully. *Subcutaneous* or superficial bones are peculiarly eligible for the operation. Its performance should be guided by two most important rules: the one negative—not to disturb the ends of bone from their bed, more than is necessary for excision; the other a positive injunction—to remove as much bone as may be requisite, thin slice after thin slice, if necessary, to expose a healthy surface of bone at either end. Their apposition, or, at the most, easy contact, is then the only local condition essential to union. Primary union should be solicited by closing the aperture, thus endeavouring to reduce the fracture to the simple condition.

Other operations have been proposed and practised, to excite reparation. The passing a *seton between* the ends, as was first successfully applied by Dr. Physick, of Philadelphia, in 1802; or, when this proceeding is impracticable, passing a seton *around* each end, as was suggested by Oppenheim. But, either way, this operation does not remove the inert ends of bone, nor can the fracture possibly be reduced to a simple condition. The seton should not be allowed to remain longer than to induce inflammation, without much suppuration. This may take place in a week or ten days; or by that time the ends of bone may be in a well of pus. Success has followed this operation, in fracture of the lower jaw, the clavicle, bones of the forearm, and the humerus; while in the other chosen seat of ununited fracture, the femur, it has been nearly a total failure. A loop of silver wire around either fragment, has been substituted for the seton; whereby also the ends have been tied together, or the wire has been tightened from time to time, until it has cut its way out. Both these modifications of the *metallic ligature* are equally objectionable, essentially, although not equally, provocative of profuse suppuration. Metallic ligatures have proved successful in the hands of Horeau; J. K. Rodgers, Mott, and Cheeseman, of New York; N. R. Smith, and Flaubert. But Norris saw an instance of ununited fractured patella, in which this treatment was fatal on the fourth day.

(*c*.) *False-joint—incomplete*—presents a different structural condition, yet a further consequence of ununited fracture. Any operation of a destructive character, as by the removal of the ends of bone—although partially absorbed and indisposed, therefore, to unite—is overruled by the fact that a connecting medium, in the shape of a band or bands of *ligamentous tissue*, already exists, which may be induced to

become the *matrix* of ossification. Hence, in this case, the *introduction* of a *foreign body* here and there, around the false-joint, may have this result. The operation, originally proposed by Dieffenbach, can be readily accomplished, by cutting carefully down to the seat of fracture, and drilling holes in the fragments with Brainard's perforator or the Archimedean drill, taking care that the point does not slip to either side of the bone, into perhaps a large artery or nerve; then introducing ivory pegs, four, five, six, or more, and driving them home with a mallet. The fracture, thus made compound, is reconverted into simple, by at once closing the incision with sutures, and lint-dressing. It may remain simple, but generally the wound reopens, with immense swelling around the part and profuse suppuration. Thence the peril, to limb and life, of this operation. The pegs must be forthwith extracted, leaving the fracture in a worse state than before; thus rendering amputation perhaps unavoidable, and even sacrificing the life by the severe constitutional disturbance. If the wound remains tolerably quiescent, and consolidation of the fracture is found to have taken place after the lapse of a month or six weeks, the line of incision must be reopened by an incision and the pegs withdrawn, their extraction being very easily accomplished, owing to partial absorption or disintegration of the portions impacted in the bone. The wound may possibly again heal by primary union; or now run the course of granulation and free suppuration tediously to recovery, and with considerable impairment of the general health, consequent on the double operation and protracted process from first to last.

Various authors bear testimony to "several" and "numerous" instances of perfectly successful results in their practice; but I am unable to find the particulars of such cases. For my own part, I have not hitherto experienced, nor witnessed, much of a satisfactory character in the results of this operation. In one case of false-joint of the humerus, at about the insertion of the deltoid muscle, I introduced four ivory pegs. That operation failed. I repeated it, and it caused such swelling and tension of the arm as to compel me to withdraw the pegs; but the false joint remained nearly as movable as before this twice-performed operation. In another case, a false joint of the femur, about the junction of the lower and middle thirds, I saw the same operation performed; but it was not repeated, and the result was not more effectual.

(*d*) *Complete* false joint—the most irrecoverable structural condition—suggests the same operation as for the incomplete condition; the introduction of ivory pegs, as foreign bodies, to induce ossification in the capsular ligament already existing as a matrix. But it should be thoroughly considered, whether the uncertainty of such reparation taking place, and the peril of the operation, are not advantageously counterbalanced by a condition of structure, which, although not that of united fracture, is yet a firm connection, and with which the limb is proportionately useful. Under these circumstances, it may be *better* "to let *well* alone." Some form of supporting contrivance might perhaps be worn with advantage, in this and other conditions of Ununited Fracture, where other procedures have failed; or rather than run the risk of almost any operation.

Disunited Fracture is a parallel *condition* to Ununited Fracture. Union having taken place, and with firm osseous consolidation, a

Fracture may again become disunited, loose and movable. The *causes* of disruption may be local; as mechanical violence, occasioning immediate destruction of the callus, or inflammation affecting it, and operating more slowly; or possibly some constitutional causative condition, as scurvy. The *treatment* accordingly must have reference to the nature of such causes.

CHAPTER XXXII.

SPECIAL FRACTURES.

Fractures of the Cranium.—These Fractures are so intimately related to Injuries of the Brain, that they are more conveniently considered with those lesions.—See Head-Injuries.

Fractures of the Spine.—See Spine.

Fractures of the Facial Bones.

(1.) Fracture of the Nasal Bones.—*Structural Condition.*—Displacement of the bones may be slight; or the bridge of the nose flattened or sunk; with more or less contusion of the integuments, extending even to the cheeks. The lachrymal bone, sometimes, participates in the injury, with rupture of the lachrymal sac, or of the nasal duct. The cribriform plate of the ethmoid bone has, it is said, been found driven up into the brain, thus occasioning serious or fatal injury to that organ.

Signs.—Hæmorrhage from the nose is often profuse and persistent. In one case in the Hospital, a policeman, whose nose had been broken on several occasions of conflict with ruffians, nearly bled to death. The *appearance* of the nose before the supervention of swelling is characteristic, if there be much displacement; and then, the loose mobility of the fragments, and their crepitation in the spongy swelling, when lightly handled with the fingers—feeling sometimes like a bag of fragments—will at once suffice to detect the nature of the injury. The discharge of tears over the face, with emphysema of the eyelids and forehead, denote an extension of the fracture laterally to the lachrymal bone. Some symptoms of concussion of the brain may accompany the fracture; or those of compression, owing probably to an extension of the fracture to the ethmoid plate.

Causes.—*Direct* violence is the only mode of fracture of the nasal bones. And such force must, usually, be considerable, to break down the articulations of these bones with the frontal and superior maxillary bones. A severe blow or fall are the ordinary causes of this injury.

Course and Terminations.—Union takes place, and with tolerable readiness, not perhaps more than a week elapsing, in most cases. There is a notable absence of provisional callus around the bones, according to the observations of both Malgaigne and Hamilton. Deformity in

some degree, however, usually results, either from the fracture having been overlooked, or owing to the difficulty of maintaining adjustment. But exfoliation of portions of the bones, with a fœtid discharge, may prolong the recovery for some time. In one such case, under my care, the patient having broken his nose by a fall, he subsequently received some further damage from the brim of his hat being accidentally thrust over his brow in getting out of an omnibus. The angular depression, where the formerly prominent bridge of his nose had been, and the upturned or snubbed extremity of the nose, gave him an unhappily conspicuous appearance. Shortly, a fœtid discharge commenced, and continued so profusely, as to run downwards into his throat when he lay down, or from the nostrils when he sat up. This offensive condition, with a clasping, bewildering pain across the forehead, and constant sleeplessness or horrid dreams, made his life miserable. Exfoliation of portions of bone, from time to time, gave him occasional relief.

Treatment.—Without displacement of the bones, cold lotions or other applications, to subdue the inflammatory swelling, will be the only interference requisite. With displacement, the bones must be adjusted by a little manipulation externally, and within the nostrils by means of a director or other such instrument. Compresses should then be applied to retain the bones in position. *Persistent hæmorrhage* can be arrested only by plugging the nares, posteriorly and anteriorly, irrespective of any immediate consideration for the fracture. This proved effectual in the severe case of the policeman. The fracture may be adjusted in the course of a few days. *Exfoliation* of the bones, and discharge, must be treated according to circumstances. Alum injections, and the administration of iodide of potassium, proved signally beneficial in the case above referred to; although the history of the gentleman—a married man, and beyond middle life—gave no evidence of any syphilitic antecedents. Union, with *malposition*, whether by lateral displacement or depression, as a "broken nose," is very unsightly. But this deformity can sometimes be overcome by Mr. W. Adam's procedure—the forcible straightening of the displaced nasal bones, septum, or cartilage with a strong pair of forceps. The parts should then be retained in position, by the patient wearing a steel screw-compressor, applied so as to support the *septum;* one blade being placed in each nostril, and the screw tightened just enough to hold the blades in contact with the septum, but without pressure upon it. This apparatus is removed after two or three days, and replaced by ivory plugs, to maintain some distension of the nostrils and support the septum. These plugs can be readily used by the patient. To support the *nasal bones*, nothing can be worn within the nostril, high up, owing to the small size of the cavity and the sensitive nature of the lining membrane, at that part. The retentive apparatus, externally, consists of a pad adjusted by cog-wheels, attached to a steel head-band; forming a nose-truss. Successful results of replacement have been obtained after deformity of months' or even of years' duration.

(2.) Fracture of the Septum Narium—occurring in connection with fracture of the nasal bones—may also happen, separately. The fracture generally takes place in the perpendicular plate of the ethmoid, adjoining to the vomer, and is produced by a blow or fall on the nose, insufficient to break the nasal bones. Displacement of the *cartilaginous portion* of the septum is, however, the more frequent form of lesion; the septal

cartilage being dislodged to one side, usually at its articulation with the osseous septum, although I have seen a similar displacement at the junction with the alar cartilage, just within the nostril. It was produced by a fall on the nose, and the subject, a little girl, looked much disfigured by the broken-nosed appearance.

Examination within the nostril will at once disclose the nature of the injury; the plate of bone, or the cartilage, can be seen and felt projecting to one side; and in the latter case, the whitish aspect of the cartilage appears plainly through the thin, tense mucous membrane.

The fracture or displacement may be more or less readily reduced by manipulation within the nostril; but to maintain the parts in position, by the application of compresses, will tax the Surgeon's ingenuity.

(3.) Fracture of the Malar Bone.—Comminuted in most cases, displacement of the fragments is inconsiderable, although spiculæ may be driven into the temporal muscle. The mobility and crepitation of the broken portions are scarcely rendered imperceptible by the swelling, which, however, is often most conspicuous. Fracture of other facial bones usually co-exists. As a very rare form of injury, the bone may be driven in, and perhaps also the antrum of the superior maxilla, thus causing a marked flattening of the cheek, and irregularity in the line of the teeth. This double displacement and impaction occurred in a patient of mine, who was thrown from a carriage, on to his face, sustaining at the same time a compound fracture of the external table of the frontal bone. He recovered from this injury, but the disfigurement remained.

Direct violence is the only cause, and the violence must be very great, as the bone, thick and solid, and supported by its surrounding articulations, offers great resistance. Hence, fracture rarely happens, compared with that of the nasal bones, although the malar is equally exposed. A heavy blow on the malar bone produces a starred and radiated fracture, just as a thick plate of glass, in a frame, is broken by a stone.

Treatment.—Cold lotions may be applied in the first instance. Adjustment of the fragments will hardly be necessary, or may be accomplished by manipulation, partly, within the mouth; they are then retained in position by compresses suitably placed. The pain insures rest, any attempt to masticate or speak being intolerable. Fragments driven into the temporal muscle should be removed.

(4.) Fracture of the Zygoma is liable to occur with, or without, fracture of the malar bone. Some displacement inwards or outwards—a depression or projection—may be felt, but can scarcely be seen, as swelling soon supervenes; rendering also any mobility or crepitation, perhaps, imperceptible. A certain stiffness is sometimes experienced in opening and closing the mouth, owing to impaction of the fragments in the tendon of the temporal muscle. In one case, I found the *articulation* of the zygomatic process of the temporal bone with the malar severed, unaccompanied by any fracture.

The broken or disarticulated ends of bone must be kept in apposition *secundum artem.*

(5.) Fracture of the Upper Jaw.—The *nasal process* of the superior maxilla is liable to fracture with the nasal bones; and this must

occur if the fracture extends outwards to the lachrymal bone, across the nasal process of the superior maxillary bone. The nostril is more or less closed by displacement of the fragments inwards. The *alveolar process* also, a much thicker portion of this bone, is occasionally broken, thus displacing the line of the teeth. The *malar eminence*, externally, may participate in fracture of the malar bone with which it articulates; and the *antrum* of Highmore is, sometimes, crushed.

Direct violence only can occasion these severe injuries. Gunshot wound, or the handle of a crane revolving and striking the face, thus produces fracture; involving, possibly, all the bones of the face in one common smash, or disjunction, with pulpifaction of the integuments. The face "feels like beans in a bag." I have seen two such facial bags; the one resulting from machinery, the other from the compression of a cart wheel passing over the face.

Treatment.—The contusion, which accompanies fracture of any portion of the upper jaw, always requires the application of cold lotions or the usual means to subdue inflammatory swelling. Adjustment of the fragments must be accomplished by proper manipulation within the mouth, and retained by any suitable contrivance. None of the fragments should ever be removed, this conservative principle in the treatment being strongly urged by Malgaigne, Larrey, and other Surgeons, as union will be found to take place very readily.

Fig. 204.*

(6.) Fracture of the Lower Jaw.—*Structural Conditions.*—This bone may be broken in any part; the *body*, and particularly *between* the symphysis and insertion of the masseter muscle (Fig. 204); rarely at the *symphysis*, in the *rami*, or the *processes*. Commonly, fracture is limited to one side of the bone. Its direction may be transverse, or oblique; and in the latter form of fracture, the pointed end of the anterior portion is apt to pierce the mucous membrane of the mouth, or to be tilted upwards by the depressing action of the genio-hyoid muscles; thus, in either way, rendering the fracture *compound*. This condition of fracture in the lower jaw has, I believe, been questioned; but I distinctly found it in one instance of fracture of the body on the left side, which had become compound, in the course of a few days, by the tilting effect of the depressor muscles; the nature of the injury having been overlooked and no retentive apparatus applied.

The *Signs* are some unevenness along the base of the jaw, and irregularity of the teeth, with mobility and crepitus when the parts are handled. The patient even experiences a harsh grating sound, conveyed through the temporal bone, as well as pain, on moving the jaw. The anterior portion is drawn downwards by the genio-hyoid muscles, and particularly if the fracture be in front of, and therefore unresisted by, the masseter muscle. Fracture on either side of the symphysis allows the middle, intervening portion of bone to be drawn more downwards. In any case there is also a dribbling of the saliva; which, at first, has a bloody tinge, from laceration of the gums, especially if the fracture be compound. Fracture of the *processes* is

* St. George's Hosp. Mus., 1, 38.

less easily recognized. The condyloid process, when detached, will be drawn forwards by the external pterygoid muscle.

Direct violence is always the cause of fracture in the lower, as well as in the upper, jaw; and such force must be considerable, as the bone is very thick, and readily moves from side to side.

Treatment.—The fragments can be easily adjusted, but less easily retained. Very many contrivances have been devised, which may be comprised under the names of ligatures,—such as silver or platinum wire, or strong silk thread; splints; bandages; and various forms of apparatus. It will suffice to notice the appliances which are commonly eligible, and successful in their results. A pasteboard or gutta-percha splint may be moulded to the base of the jaw (Fig. 205); the upper jaw being used as a splint above. A four-tailed bandage, with a hole in the centre to

Fig. 205.

Fig. 206.

receive the chin, is then applied; two ends tied over the top of the head, and two behind the neck, thereby fastening the jaw, both ways, in position. (Fig. 206.) Fluid nourishment only is allowed, which can be sucked in between the teeth. Double fracture, and near the symphysis, with greater depression of the fragment, requires the more steady and firm support of the clamp apparatus, contrived by Lonsdale. Loose teeth may, possibly, be preserved by fastening them to the sound teeth with fine gold or silver wire. But any tooth which would prevent even apposition of the fragments, should be removed. Advantage may perhaps be taken of the opening thus made, to feed the patient through a suction tube, during the process of reparation. Union, and generally osseous, takes place usually in a month or five weeks. The resulting deformity is slight; scarcely to be seen or felt by external examination, and amounting mostly to a little irregularity in the line of the teeth, owing to some depression of the anterior fragment.

Wire ligature has been employed in fractures of the jaw by American Surgeons, especially Dr. Buck and Dr. Hamilton, and in this country by Mr. Wheelhouse, of Leeds; but this mode of treatment has been brought into notice more particularly by Mr. Thomas, of Liverpool. He has devised various methods of applying the ligature to secure the fractured portions together, and instruments for drilling the bone when necessary, and for fastening the wire. Silver annealed wire is used, the thickness $\frac{1}{32}$ inch, so as to be easily manipulated, and yet of sufficient strength to retain its hold. The annexed figure represents one mode of applying the ligature. (Fig. 207.) The silver wire is passed through the opening at A. Then, the tubular needle (not shown) is passed through another aperture at B, into the open end of which instrument the return end of the wire being introduced, is

withdrawn with the needle. The end of the wire at A is to be inserted into the slit of the key in figure, and twisted in three or four coils;

Fig. 207.

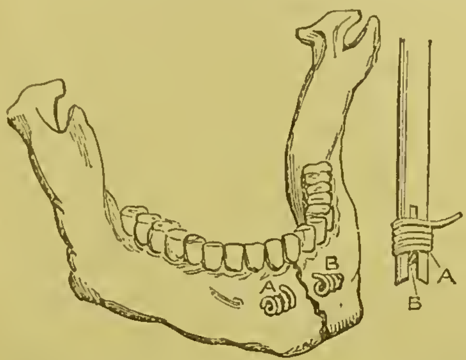
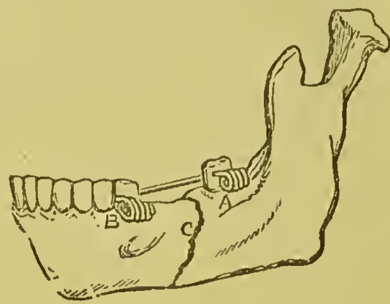


Fig. 208.



and then the end of wire at B must be twisted in like manner until the fracture is firmly fixed. The wire will require to be tightened as it loosens, every three or four days. Or the wire may be secured around the teeth, in other cases, as here shown. (Fig. 208.) A hole was bored from without backwards and inwards across the third molar tooth A, below the enamel, this tooth being firm in the posterior portion of the fracture. The wire having been passed through this hole, from without inwards, was brought forward between the bicuspid and canine teeth A. Then, the ends of the wire were coiled with the key. After ligature, union takes place in three or four weeks, when the wire may be removed. So firmly secured are the fractured surfaces by a skilful application of the ligature, that the patient may have to be restrained from using the jaw in mastication. And the satisfactory results which have been obtained certainly recommend this method of treatment. I have practised it with success in two or three cases. But the wire ligature must be restricted to certain cases only. In compound fracture of the jaw, this method is eligible; but it would not be advisable to drill the bone, and possibly convert a simple fracture into compound. Then again, in the absence of teeth or in an edentulous jaw, the application of a ligature may be difficult or impracticable, as an alternative method of treatment.

Fracture of the Hyoid Bone.—The injury occurs very rarely. The body of the bone may be broken, as in hanging; but more commonly, one of the great cornua gives way. In one instance I have seen a fracture at the junction of the great cornu with the body of the bone, on the left side.

The mobility, and perhaps crepitus, with some displacement of the fragments, are sufficiently characteristic. Besides which signs, there may be a sensation of something having snapped at the time of the injury, with hæmorrhage from the throat and acute pain at the root of the tongue and in moving the organ; also perhaps difficulty in opening the mouth, or in swallowing, and loss of voice. These functional symptoms are usually associated with some amount of swelling and bruising, or more distinctive marks of violence, over the seat of injury.

Direct violence would seem to be the only occasion of hyoid fracture, as by the grip of an assassin, or by a blow or fall on the front of the neck; but it is said to have been produced also by muscular action.

Hanging, another instance of force compressing the hyoid bone, does not, I believe, generally produce fracture. Three cases only were thus caused out of the whole number of hyoid fractures, 10, which Hamilton has collected. In one case, having, by permission of the sheriffs, examined the throat of a man after execution at the Old Bailey, I found no fracture of this bone, although the rope, producing a deep, purple indentation, had passed directly over the bone.

Hyoid fracture cannot be regarded as of vital consequence in itself, union taking place, although perhaps with some delay and deformity. Yet, in connection with the causes referred to, the fracture has often a fatal result.

Treatment.—Adjustment of the fragment is easily accomplished by passing the finger of one hand into the pharynx, while coaptation is effected externally. Retention in position is far more difficult, owing to the mobility of the part, and the recurrence of deglutition. It has been proposed to embrace the neck in a firm pasteboard collar, as a splint; and thus fix the bone externally. But the liability of displacement in other directions, by muscular action, still remains a difficulty to be overcome.

FRACTURE OF THE RIBS, AND COSTAL CARTILAGES.—*Structural Conditions.*—One or more ribs, even several, may be fractured. Seven and eight ribs I have seen broken, counting from the second downwards. The first, and perhaps the second rib, are seldom fractured, they being protected by the clavicle; and the last two false ribs also escape, as being floating, or freely movable. The mid-ribs, most exposed and fixed, are, usually, the seat of fracture. Any part of a rib is liable to be broken, by direct violence; but the convexity, or near the angle, yields mostly under the force of compression. Thus the mid-ribs, somewhere in a line from the axilla downward, present the fracture commonly met with. The line of fracture is generally transverse, sometimes oblique; rarely, there is comminution. Displacement may be outwards, or inwards; seldom upwards or downwards, the intercostal muscles apparently restraining the broken ends in either of these directions. Longitudinal displacement, in the axis of the bone, is apt to occur when several ribs are broken. The pleura and lung are specially liable to injury simultaneously; rarely, the pericardium or heart, the diaphragm, and liver.

Compound fracture occurs sometimes, as by gunshot wound.

The *Signs* of fracture are crepitus, and some mobility, felt on placing the hand over the seat of injury, while the patient coughs or breathes hurriedly; and some irregularity or flattening in the course of the ribs can usually be detected, at least during such respiratory action. A catching pain, occasionally disturbing the respiration, elicits these signs more palpably. Hence the breathing is soon restrained, and becomes more abdominal. Hæmoptysis, or a spitting of blood, pneumothorax, or a tympanitic accumulation of air in the pleura, and general emphysema of the subcutaneous cellular texture, may be further signs of fracture; indicating that the injury implicates the pleura and lung, that both are penetrated by the fractured end, or ends, of bone. These additional *thoracic* symptoms are all-important, as the respiration will then be yet more embarrassed. But great oppression may also arise from compression of the chest by the act of fracture, without any penetration of the pleura and lung.

Causes.—*Direct* violence, as the cause of fracture, produces displacement inwards, with, probably, some wound of the pulmonary organs, or other viscera occasionally. *Indirect* violence, as compression of the chest by a wheel passing over it, produces displacement of the fractured ends, outwards, and contusion of the viscera. The former condition of injury will, probably, be limited; the latter more extensive: the one also may be fracture of any rib, at any part of its extent; the other is generally that of the mid-ribs, at their convexity. Loss of elasticity in the ribs would seem to render persons of advanced years more liable to fracture arising from any compressing force. On the other hand, in childhood, the thorax yielding with cartilaginous resistance, great compression, as by the passage of a carriage-wheel over the chest, is not necessarily attended with fracture. A similar accident to a young retriever dog, which I witnessed, caused no appreciable injury; the animal whining only for a few moments, although the wheel had left its mark plainly across the chest. *Muscular action* has been known to cause fracture of the ribs; as by contraction of the abdominal muscles during parturition.

Course and Terminations.—Fracture unattended with any damage to the thoracic organs, proceeds favourably; union of the ribs taking place, with facility, in four or five weeks. Slight deformity only remains, as the result of some displacement, and of ensheathing or provisional callus. Between adjoining ribs, plates of bone have sometimes formed, as a supplemental bond of union. Penetration of the pleura and lung may be followed by some inflammation of either—by pleurisy or pneumonia. Usually, however, any hæmoptysis, pneumothorax, or general emphysema, ceases after a time; and any inflammatory action supervening, has not a fatal issue. Contusion of the viscera by compression may soon prove fatal; but the almost momentary subjection of the chest to such force, is sometimes followed by no unfavourable consequences, although there be extensive fracture of the ribs.

Treatment.—Fracture, by itself, requires simply the application of a broad rib-bandage round the chest, in order to arrest thoracic respiration; thus securing the ends of bone in apposition, and at rest as much as possible. Any displacement may generally be overcome by compresses suitably applied; as over the sternum, to increase the convexity of the ribs, in the case of displacement inwards; or two compresses, one on either fractured end, in the case of projection outwards. The rib-bandage is itself secured in position, if necessary, by a vertical bandage over the shoulders, and abdominal strips passing round the buttocks below. These accessory restraints are useful in fat persons. A broad roll of adhesive plaster may be drawn once or twice round the chest, instead of a rib-bandage. It answers better, probably, mechanically, and is not likely to shift its position; but it is a dirty, irritating thing, and as such I rarely use plaster, unless several ribs are broken. Medicinally, an anodyne cough mixture may be of service, to allay the pain and cough of irritation, consequent on the respiratory movements; but if the chest be well fixed, the case experienced will be considerable.

Penetration of the pleura and lung is more important than the fracture. Hæmoptysis, pneumothorax, and emphysema, alike require moderate depletory measures; thus to reduce the general circulation,

and to relieve the embarrassment of the respiration occasioned by compression of the lung, in pneumothorax, or of the chest, in emphysema. Venesection, therefore, sometimes proves singularly beneficial, affording instant relief. In a case under my care in the Hospital, emphysema extended from the chest downwards to the iliac fossa, on the left side; attended with the usual crepitation, stuffed appearance, and great oppression of the respiration. Mr. Jeaffreson, the House Surgeon, seeing the urgency in this case, at once bled the patient, taking away more than a pint of blood. The effect was marked, and almost magical. Panting and prostrate as the man lay before losing blood, he soon sat up and breathed freely; recovering without any further unfavourable symptoms. Scarification of the emphysematous cellular texture may sometimes be resorted to, alone, or with venesection. But the air gradually disappears spontaneously in most cases. *Paracentesis*, or tapping the chest, has been performed for the relief of severe pneumothorax.

Inflammation of the pleura or lung, supervening, must be met by the treatment appropriate for pleurisy and pneumonia.

Compound fracture of the ribs, resulting from gunshot wound, is similar in all respects, otherwise than relates to the treatment of GUNSHOT WOUNDS.

FRACTURE OF THE COSTAL CARTILAGES may occur in any part of their extent from the ribs to the sternum, or at their articulations with either of these bones—a dislocation, more strictly speaking. Any such injury to the cartilages takes place in connection with fracture of the ribs; sometimes, however, independently. The pathology being analogous to that of fractured ribs, the treatment requires no special notice. And although the costal cartilages are often fractured prior to any ossification, union ensues through the medium of bone, forming an intermediate callus, an ensheathing callus also being supplied by the perichondrium.

FRACTURE OF THE STERNUM.—*Structural Conditions*.—Analagous to fracture of the ribs in most particulars, fracture of the sternum is commonly transverse, very rarely longitudinal, and usually single; but this bone may be broken into three or more pieces. Displacement seldom occurs, and then the lower portion projects forwards, and perhaps just overrides the upper; although backward displacement of the same fragment has been met with. Extravasation of blood into the anterior mediastinum, injury of the pericardium and heart, or of the pleura and lung, may severally accompany fracture. Fracture of the sternum is usually accompanied with fracture of the ribs, in their convexity; the same compressing force producing both injuries simultaneously. I have never yet seen the sternum broken alone. The ensiform cartilage may be driven backwards, and remain permanently depressed, even when in a cartilaginous state, and subject to the resiliency of its own elasticity.

Compound fracture occurs sometimes, as by gunshot wound.

The *Signs* of this fracture are obvious: crepitus, and some mobility, felt on applying the hand over the sternum during coughing or the hurried respiratory movements; while some inequality of the bone, with any displacement, will also be perceptible. The respiration is principally abdominal. Hæmoptysis and emphysema, or severe palpitation, are present, when the injury involves the lung or heart. Or-

these organs may evince symptoms of having suffered compression, without penetration.

The *Causes* relate to various occasions of *direct* violence, as the wheel of a carriage passing over the chest, or gunshot wound; but the elastic and yielding nature of the ribs and their cartilages, and the spongy texture of the sternum, resist fracture of this bone. Hence, although much exposed, it is rarely broken. But as *age* advances, and the costal cartilages undergo ossification, the liability to fracture of the sternum increases. *Muscular action* also is said to have caused fracture; as violent contraction of the abdominal muscles during parturition, efforts at lifting heavy weights, or a fall on the back across a beam.

Treatment.—Position is of some importance, to relax the abdominal muscles more especially, and thus prevent displacement of the lower portion of bone forwards, which would result in angular deformity. If the patient be recumbent, the pelvis should be slightly raised; or sitting up, the shoulders should incline forwards. A broad bandage, encasing and fixing the chest, is applied, as for fractured ribs. It should be secured, observes Hamilton, when the patient is making a full expiration.

Fracture of the Clavicle.—*Structural Conditions.*—The clavicle may be broken in any part of its extent; commonly, in one of its two curves, and particularly, in its outer or scapular concavity. Rarely, fracture takes place external to the coraco-clavicular ligament—in that part of the bone between it and the acromion. (Fig. 209.) This distinction is important with regard to symptoms, causes, and treatment. Hence, fractures of the clavicle are divided into those on the *sternal* and those on the *scapular* side of the *coraco-clavicular* ligament, which is attached to the rough oblique line on the under surface of about the outer inch and a half of the bone. On the *sternal* side of this ligament, fracture is usually oblique, from behind forwards and inwards (Fig. 210); but it may be comminuted, from direct violence. On the scapular side also, the bone may be similarly fractured. Displacement, in any notable degree, occurs only with fracture on the sternal side of the ligament, in the outer curve where the bone usually yields. The outer or scapular portion is alone displaced; the inner portion being retained in position by the costo-clavicular ligament,

Fig. 209.*

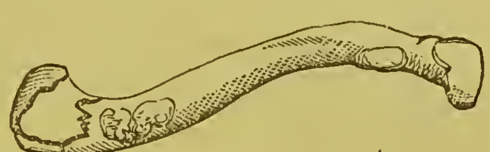
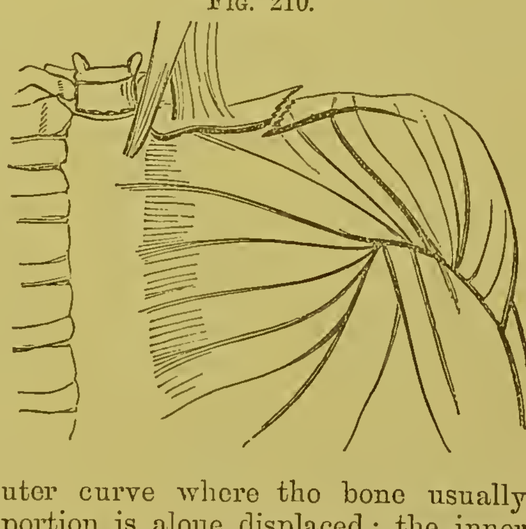


Fig. 210.



* St. George's Hospital, 1, 80. See also another case by Mr. Canton. Trans. Path. Soc. vol. xii.

and the opposed action of the sterno-mastoid and great pectoral muscles. The displaced portion is drawn downwards, forwards, and inwards; under, perhaps, the inner portion, thus being overlapped to an extent varying from a quarter of an inch to an inch. This displacement is partly due to the weight of the arm, having lost its support from the sternum; but principally it results from the action of the deltoid and great pectoral muscles, the latter muscle drawing this portion of the bone forwards and inwards. Double fracture has been met with occasionally, both clavicles being broken, perhaps more often in children.

Incomplete fracture of the clavicle may be noticed, only as an almost unique rarity, in a specimen (1, 75) of the Museum of St. George's Hospital. But, in infancy and childhood, I am inclined to believe that this lesion is not uncommon; the clavicle yielding near the middle, in a transverse direction, and with no displacement more than a slight bulging forwards.

Compound fracture has been known to occur, by direct violence, or as the result of a very oblique fracture protruding through the skin.

Complicated fracture consists in some additional injury. The structures adjacent to the clavicle are rarely injured with, or by, the fracture. But the axillary plexus of nerves and the subclavian vein have, severally, been wounded. Both these additional injuries were present, I believe, in the fatal case of the late Sir Robert Peel, whose left clavicle was fractured, and comminuted, by a fall from his horse. The injured vein led to the formation of a "diffused false venous aneurism," as large as the hand might cover, below the fractured clavicle, and which pulsated to the touch synchronously with the action of the heart, or rather with the contractions of the auricle.

The *Signs* of fractured clavicle are characteristic. When, as usual, on the *sternal* side of the coraco-clavicular ligament, a depression, corresponding to the displacement, is readily detected on passing the finger along the bone, crepitation also, and mobility of the outer portion, on raising and rotating the shoulder, the elbow being kept to the side. Pain is caused by this manipulation; and the patient is unable to raise his hand to his head, the support of the clavicle, necessary for this semicircular motion of the arm, having given way. The patient, with his other hand, holds the arm up to his chest, to relieve the powerless weight, and inclines his head to the injured side, to relax the muscles passing from the clavicle to the head. This peculiar attitude of the patient is accompanied with a marked falling of the shoulder inwards towards the sternum, approximating the interval between these points; thereby declaring the nature of the injury almost at a glance. Examination, as above directed, will be conclusive. Some contusion also may be noticed on the shoulder, or over the seat of fracture, according to the part struck, in thus breaking the bone.

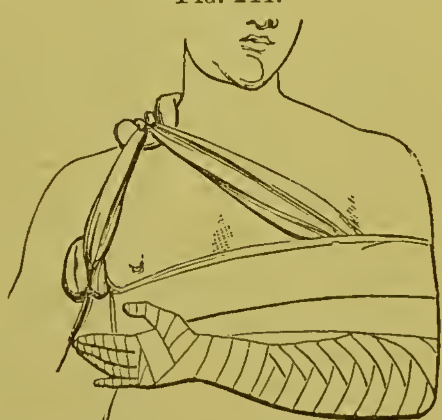
On the *scapular* or outer side of the coraco-clavicular ligament, fracture is less obvious, but still easily discovered. Slight displacement of the fragment downwards, and drooping of the shoulder, may be observable; but this irregularity disappears on pressing the arm upwards; and crepitus, with some mobility of the fragment, are felt on raising and depressing the humerus, the hand being placed over

the shoulder at the seat of fracture. The motions of the arm are scarcely impaired, as a sufficient support in the larger portion of the clavicle remains.

Causes.—Indirect violence, the more common cause, produces fracture in the usual situation—the outer curvature, and obliquely across the clavicle. The long and slender form of the bone, and its function, that of supporting the upper extremity from the trunk, render it peculiarly liable to fracture, in receiving every impulse through any of the component bones of this extremity. Thus, falls on the hand, elbow, and shoulder especially, are common causes of fracture in the curve of the clavicle. *Direct* violence produces fracture in the part struck, and probably of a comminuted character. Thus, any part of the bone, on either the sternal or scapular side of the coraco-clavicular ligament, may be the seat of fracture from direct violence. The subcutaneous and exposed position of the clavicle renders it liable to be broken in this way. A heavy, crushing blow illustrates the corresponding class of causes. *Muscular action*, as in using a whip, has been known to break the clavicle; the fracture occurring near the middle of the bone, without displacement or only slightly forwards, and usually on the right side.

Treatment.—On the *sternal* side of the coraco-clavicular ligament, displacement of the outer fragment,—inwards, forwards, and downwards, must be overcome by giving the humerus an opposite direction, —outwards, backwards, and upwards. The first direction is accomplished by a *pad* in the axilla, and the latter two, by inclining the arm inwards *across* the chest and *raising* the elbow ; Desault's method of treatment, and which I, among most other Surgeons in this country, have usually practised. To keep the pad and arm in this position, many contrivances have been used. Before applying any such retentive bandaging or apparatus, it is well to provide against the supervention of swelling in the arm and hand, by padding the palm with cotton wadding or other soft material, and bandaging from the fingers upwards to near the axilla. Then a good-sized pad, enclosed in a handkerchief, should be placed well up in the axilla, and the arm close to the side, so as to draw outwards the scapular portion of the clavicle to an even apposition with the sternal portion ; the pad being secured in its place by tying the handkerchief at the opposite side of the neck. Inclining the arm inwards across the chest, until the hand points upwards to the opposite shoulder, a few turns of a roller round the chest enclosing the arm, above the elbow, will secure this position. (Fig. 211.) The forearm should then be slung in another handkerchief, from the hand to the elbow ; care being taken that the elbow is well supported, upwards. Any particular shifting or loosening of these simple retentive appliances, subsequently, must be corrected ; but the fracture should not be readjusted unnecessarily. Union, and of an

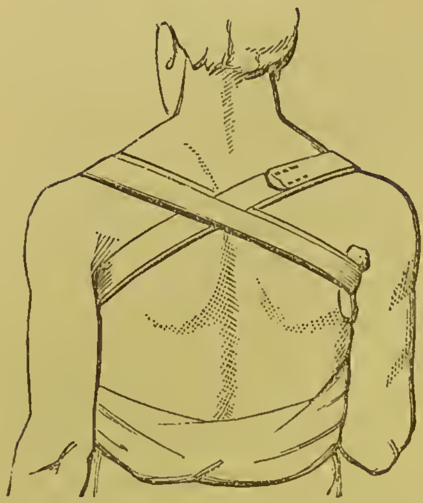
Fig. 211.



ossific character, will have taken place, generally, in about three weeks. But there is nearly always some amount of deformity and shortening of the bone (Fig. 212) as the result of this, or I believe any other, method of treatment. Fortunately, however, such defects are of little consequence, eventually, in the use of the arm.

Fig. 212.

Fig. 213.



Other contrivances may, occasionally, be more suitable; and particularly in fracture of both clavicles.

The shoulder can be *drawn* backwards, and thus kept in position, by a *figure-of-8 bandage* across the back and front of the chest, winding under either axilla. (Fig. 213.) The other appliances are the same as those already noticed: an axillary pad, and a sling for the arm. Excoriation of both axillæ is apt to be produced by this form of bandage.

Brasdor's apparatus removes this objection to a figure-of-8 bandage. Two well-padded straps are used, one under either axilla, which are buckled to a back-piece of stout leather, from which two perpendicular straps pass down to a belt around the waist; thus retaining the whole apparatus in position. The back-piece consists of two portions, laced together according to the size of the chest.

Objection has been urged, not without some reason, to the employment of an *axillary pad*, which is liable to induce paralysis of the arm, by pressure on the brachial plexus of nerves. Dupuytren, Velpeau, Syme, and other excellent Surgeons, have concurred in condemning the application of a pad.

Certain methods of treatment, of American origin, obviate the necessity for recourse to the pad, while they aim at depression of the sternal fragment by making tense the clavicular attachment of the pectoralis major muscle. *Sayre's method* consists in drawing the arm backwards, and the elbow well forward and inwards. This is accomplished by the application of two broad strips of adhesive plaster, according to the following directions, as given in Hamilton's treatise:—Each strip is about three and a half inches wide, for an adult; one long enough to encircle, first the arm, and then the body completely; the other of sufficient length to reach from the sound shoulder, over the point of the elbow of the broken limb, and across the back obliquely to the point of starting. Maw's moleskin plaster, or some material of equal strength, should be used. The first strip is looped around the arm just below the axillary margin, and pinned or stitched, with the loop sufficiently open to avoid strangulation. The arm is then drawn downward and backward until the clavicular portion of the pectoralis major is put sufficiently on the stretch to overcome the sterno-mastoid muscle, and thus draw the sternal fragment of the clavicle down to apposition with the acromial fragment. The strip of plaster

is then carried completely around the thorax, and pinned or stitched to itself on the back. The second strip is now applied; commencing on the front of the shoulder of the sound side, it is carried over the top of the shoulder, diagonally across the back, under the elbow, which must be drawn well forward and inward, thence across the front of the chest to the starting-point, where it is fastened by pins or thread. A longitudinal slit is made in the plaster to receive the point of the elbow. The leverage of the arm, thus brought to bear on the axillary loop of plaster, as the fulcrum, draws the shoulder outwards and backwards—completing the replacement of the acromial fragment. (Fig. 214.)

Fig. 214.

Another method, on the same principle, has been devised by Dr. B. M. Moore, of New York. It is "the figure of 8 fro the elbow." The arm is placed in position, by resting the end of the middle finger upon the ensiform cartilage, with the elbow pressed against the side of the body. Then a single band, two and a half yards long by eight inches wide, is applied thus: the centre being laid under the point of the elbow so as to receive it, the extremity of the band from behind is carried upwards under the axilla, and over the front of the corresponding shoulder, diagonally downwards across the back to the opposite axilla, and under to the front; the other extremity is brought from the front of the elbow upwards across the back to the sound shoulder, and forward over to the front, where it meets the extremity of the band coming from under the axilla, and the two ends are here fastened together. The forearm, flexed at an acute angle, is supported by a narrow sling under the wrist.

Fracture on the *scapular* side of the coraco-clavicular ligament may be treated in the same way as on the sternal side; the axillary pad, however, being of *smaller* size, the arm bandaged to the *side*, and the forearm supported in a sling, *slightly* raising the elbow.

In *children*, the clavicle may be bent, and this condition mistaken for fracture; the signs of fracture, in childhood, are also less perceptible, and obscured in a few days by soft union. At the end of a week, I have found such union of a clavicle, in a child two years old. The small, soft callus-swelling around the seat of fracture, which can be easily seen and felt, will at once declare the nature of the injury. *Treatment* is often very unmanageable, by bandaging; and the fracture may be conveniently secured by the starched apparatus.

Complicated fracture of the clavicle is best treated by the recumbent position, without any particular form of mechanical restraint. The injury, additional to the fracture, is generally so severe, as to render the latter of subordinate importance. This is more especially the case when the subclavian vein or the axillary plexus of nerves are implicated. In the event of pneumonia having supervened from fracture of the ribs, associated with fractured clavicle, a thoracic bandage would still further embarrass the oppressed respiration. In such

case, I have removed all apparatus, and with marked benefit. Recumbency and rest have proved sufficient for the adjustment and union of the fractures; while attention should be directed solely to the treatment of any complication. This method of treatment—by the recumbent position, without apparatus—is applicable also to simple fracture of the clavicle; but it is unnecessary to impose the restraint of such absolute immobility, and it would be prejudicial to the general health to confine the patient to bed. The posture-method is, however, as old as the time of Hippocrates, and it has since been recommended by Dupuytren, Pelletan, Lizars, Lente, of New York, and other experienced Surgeons.

FRACTURE OF THE SCAPULA.—*Structural Conditions.*—Fracture of the Scapula is liable to occur in any part of the bone; but in some parts commonly, in others rarely. This distinction has reference, apparently, to the more or less exposed situation of the bone, in its different parts. Thus, the *inferior angle* is more commonly fractured than the *body;* the *acromion* commonly; the *coracoid process*, and the *neck*, both rarely. The *glenoid cavity* may be starred, but very rarely.

(1.) The *Inferior Angle* is simply broken off, and displaced forward, being drawn in that direction by the attached portion of the serratus magnus, and by the teres major and latissimus muscles.

The *Signs*, therefore, are this displacement, and the mobility of the fragment apart from the body of the bone, or the stationary position of the angle when the scapula is moved.

FIG. 215.

(2.) The *Body* may be fractured transversely or longitudinally; in the former direction usually, and close below the spine of the scapula. (Fig. 215.) Little displacement can take place, the fragments being embraced by muscles; but with completely transverse fracture, the lower portion is drawn forward.

The *Signs* are some displacement, in transverse fracture discovered more readily, as an irregularity of the posterior border of the scapula; with perhaps crepitus and mobility of the fragments, on using some degree of pressure to and fro in the direction of fracture.

(3.) The *Acromion* may be knocked off at its tip, or nearer its root (Fig. 215); it is drawn downwards and slightly forwards by the deltoid muscle, and the weight of the arm.

The *Signs* are very conspicuous. Downward displacement of the fragment, and dropping of the arm, give a marked flattening to the shoulder; and the inequality of the spine of the scapula can be felt on passing the finger upwards in its course to the depressed fractured portion near the clavicular articulation. Crepitus and mobility of this portion of the bone are also felt on pressing upwards and rotating the arm, the other hand being placed over the shoulder; and the deformity of the shoulder then disappears, but it returns when the arm is again allowed to drop. The patient feels as if the shoulder were dropping off, and experiences a great sense of weight and powerlessness in

attempting to raise the arm. Bony union is rare; sometimes even a false-joint forms. (A. Cooper.)

(4.) The *Coracoid Process* is sometimes knocked off; it will be drawn downwards by the biceps and coraco-brachialis muscles, and inwards also by the pectoralis minor. (See Fig. 216.)

The *Signs* are partly obscure; no particular alteration in the shape of the shoulder, though the apex of the coracoid process can be felt lower than on the sound side; but mobility of the fragment, with possibly crepitus, are very perceptible on fixing the scapula and moving the arm backwards and forwards. Fibrous union is not uncommon.

Double fracture of the acromion and coracoid processes occurred in one remarkable case, with fracture also of the body of the scapula, passing through the spine and supra-spinous fossa, posteriorly. This extensive injury was produced by direct violence,—the wheel of a dust cart crushing the shoulder. (King's Coll. Mus., 1170–2.) See also "Path. Trans.," 1869, vol. xx., p. 270.

(5.) The *Neck* of the scapula—beyond the root of the coracoid process—is occasionally broken off carrying with it the glenoid cavity (Fig. 215), and coracoid process, and, perhaps, the acromion, with the

FIG. 216.

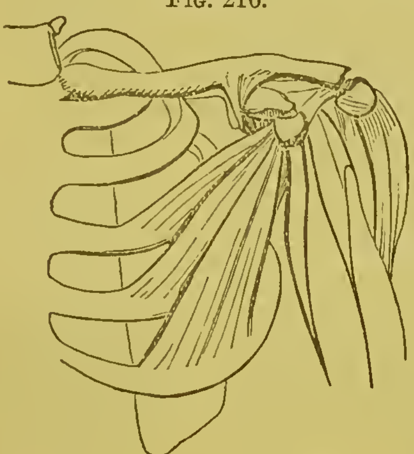


FIG. 217.

adjoining portion of the spine of the scapula (Fig. 217), which together fall downwards and inwards by the weight of the extremity. Fracture of the anatomical neck alone—exclusive of the coracoid process—perhaps never occurs; not a single specimen of such fracture existing in the museums of the London Hospitals (South), nor in any of the American cabinets (Hamilton). The coraco-clavicular and coraco-acromial ligaments may be more or less ruptured, thus allowing of different degrees of displacement.

The *Signs* are marked flattening and dropping of the shoulder, a depression under the acromion, and a tumour in the axilla; thus far simulating dislocation downwards into the axilla. But mobility, and crepitus of this apparent head of the humerus, can be readily discovered by placing the hand on the shoulder, with the forefinger resting on the coracoid process, and rotating the arm; the crepitus being transmitted through that process, which still remains uninjured in its connection with the glenoid cavity, and the process moving with the humerus, instead of remaining fixed on the scapula, supported by the other hand. Moreover, the deformity of the shoulder disappears, and returns, as the

neck portion of the scapula is replaced and displaced, by pressing the arm upwards, and then allowing it again to drop.

(6.) The *glenoid cavity* may be the seat of a starred or comminuted fracture, of which there is an excellent specimen in the Museum at Netley (Fig. 217); or, with fracture of the glenoid cavity, the acromion and coracoid processes may also be broken. This rare injury occurred in a case of which the specimen is preserved in the Museum of University College, 249. (Fig. 218.) The *diagnostic signs* of such fracture would be obscure.

Comminuted fracture of the body of the scapula is even a more rare form of injury than the preceding; but I have found several specimens in the Museums of St. George's Hospital and University College.

Cause.—Direct violence is the only cause of fracture, in any part of the scapula. The body is especially protected by a cushion of muscle, on the back and front of this portion of the bone; and the coracoid process and neck of the bone are cushioned by the deltoid muscle. Thus protected, the violence must be very considerable to produce fracture, especially when comminuted; not unfrequently, the subjacent ribs are broken simultaneously, and severe contusion or laceration of the soft parts, with such additional injury, give rise to serious consequences.

Fig. 218.

More than one fracture of the scapula may have occurred; or fracture, concurrently, of the upper end of the humerus.

The occasions of direct violence are various. A heavy fall on the shoulder may fracture the acromion, coracoid process, or neck of the scapula; a severe blow, as by the pole of a carriage, has fractured the coracoid process; and gunshot injury of the back may fracture the body of the scapula.

Treatment.—The direction of the *displacement* indicates the proper position of the limb, and the application of retentive bandaging.

Displacement forwards of the *inferior angle*, or a portion of the *body* of the bone, will be corrected by drawing the arm inwards, and thence the scapula forward; in order thus to meet the fractured portion, which cannot easily be kept back, although a compress may be placed in front of it, as Boyer recommended. The arm must then be secured in that position, by a few turns of a roller round the chest, and the forearm rested in a sling.

Displacement downwards and forwards of the *acromion*, or downwards and inwards of the *coracoid process*, or with the *neck* of the scapula, may severally be rectified by elevation of the arm with an inclination inwards, in order to replace the fractured portion upwards and backwards, or upwards and outwards. In fracture of either of these portions of the bone, the downward tendency—with flattening and dropping of the shoulder—is more marked than any tendency forward, or inward. Having, therefore, secured the arm slightly in front of the chest, by a few turns of a roller, the forearm must be well supported in a sling, especially at the elbow. In fracture of the

neck, an axillary pad will be necessary to guard against the recurrence of displacement. Thus, the treatment of fractures of the scapula, and of the neck in particular, resembles that for fracture of the clavicle.

Contusion of the soft parts, often severe, may render it impossible or improper to finally adjust the fracture, until the swelling and pain, thence arising, have partly subsided under the application of cold lotions or other appropriate measures.

The union of all fractures of the scapula almost always results in some amount of deformity, owing to the tendency to displacement under the most careful treatment.

FRACTURES OF THE HUMERUS.—Fracture of the Humerus is liable to occur in any portion of this bone; in the Upper Articular end, the Shaft, or in the Lower Articular end. (Fig. 219.)

FIG. 219.*

FRACTURE OF THE UPPER ARTICULAR END may take place in either of three situations. (1.) *Intracapsular* fracture—within the capsule—or of the *anatomical* neck. (Fig. 220.) The head remains in the glenoid cavity, while the shaft of the bone is drawn upwards and forwards to the front and outer side of the coracoid process. It was formerly a question whether this fracture ever occurred. The possibility has long since been verified by dissection. Such a case is described in Sir A. Cooper's work; and similar individual specimens are recorded as having been seen by Bichat, Delpech, Robert Smith in two cases, Pirrie, and other authors. Displacement sometimes accompanies the fracture; either as a dislocation, or by reversion of the head, the cartilaginous surface resting on the osseous surface of the lower fragment—a rare form of displacement, but of which a specimen was seen by Nélaton, in the possession of M. Dubled, and another by Dr. Robert Smith.

FIG. 220.†

Signs.—A projection, corresponding in situation to the end of the lower portion,—the shaft, can be felt on the outer side of the coracoid process, and some flattening *lower* down may be perceptible—the deltoid being spread inwards by the shaft. But immediately below the acromion there is no hollow, the head of the bone remaining in the glenoid cavity; and this negative difference in the outline of the shoulder distinguishes fracture of the neck of the humerus from dislocation. Crepitus, and immobility of the head of the bone, may

* Fractures of Humerus. Diagram showing situations and lines of fracture; chiefly from specimens in the Museum of St. Bartholomew's Hospital.—1. Anatomical neck (St. George's Mus. 1, 89). 2. Surgical neck. 3. Upper third. 4. Middle third. 5. Lower third. 6. Above, and through condyles, into elbow-joint (Royal Free Hospital). 7. Internal condyle. 8. External condyle. (Author.)

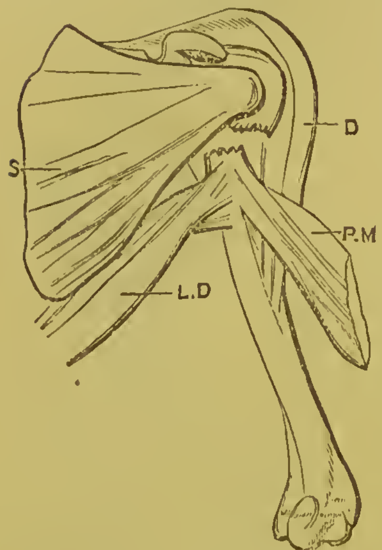
† St. George's Hospital Museum, 1, 89. Fracture of the neck of the Humerus—the "anatomical neck," in part; but for the greater part of its course, through the "surgical neck" of this bone. The patient, a young man, was carrying a heavy weight under his arm, and fell from a considerable height. Amputation at the shoulder-joint. This rare specimen of fracture was presented by Sir B. C. Brodie.

also be felt on extending and rotating the humerus; if the muscular development of the deltoid and the swelling consequent on contusion, do not together form a cushion of such thickness as to obscure these signs. Slight shortening of the arm will be discovered by measuring, as compared with the other arm, the distance between the acromion and olecranon processes. Considerable pain is experienced on moving the arm in examination; and it hangs powerless by the side. In the case of a female, aged 81, I was led by the signs to recognize this fracture, which, having regard to the functional symptoms, had been mistaken for a sprain.

Impacted fracture of the anatomical neck is attended with a notable absence, or lesser degree, of the ordinary symptoms; the shaft having been driven into the head of the bone. It more resembles dislocation of the shoulder into the axilla.

(2.) *Extra-capsular* fracture—beyond the capsule—and of the *surgical* neck (Fig. 221), which includes the portion of bone below the tuberosities and above the insertions of the three muscles into the bicipital groove—the pectoralis major, latissimus dorsi, and teres major muscles. Fracture in this situation is, sometimes, very oblique. The shaft of the humerus, below the fracture, is drawn inwards and upwards by the action of these three muscles; and the upper fragment outwards, by other three muscles inserted into the great tuberosity, the supra-spinatus, infra-spinatus, and teres minor, counteracted, however, by the sub-scapularis muscle inserted into the small tuberosity.

FIG. 221.*



Signs.—Deformity of the shoulder is presented, under cover of the deltoid muscle, but *lower* down than in fracture of the anatomical neck. And, the deformity corresponding to the displacement of the two ends of bone, it consists of a *double* projection, inwards of the lower end, and outwards of the upper end. Mobility of the lower end, and crepitus on extension and rotation, with some inclination of the humerus inwards, and shortening of the arm, are even more perceptible signs. Pain, severe during any manipulative examination, owing to irritation of the axillary plexus by the shaft-fragment, and inability to use the arm, conclude the diagnosis.

Separation of the *Upper Epiphysis* from the shaft of the humerus may occur at the line of junction, just below the tuberosities and the commencement of the surgical neck. The signs are the same as in fracture of the surgical neck. But separation of the epiphysis happens only in childhood or youth.

Impacted fracture of the surgical neck is chiefly characterized by the absence, or minor degree, of the ordinary symptoms. But the fracture is too low down to be well mistaken for dislocation into the axilla.

Double fracture—namely, through the anatomical neck, and also through the surgical neck of the humerus—may be noticed, as a

* After Gray.

possible form of injury. In a specimen belonging to Dr. Pope, of St. Louis, the upper fragment was reversed upside down, and the lower fragment was displaced in the direction of the coracoid process; both were united by bone. (Hamilton.)

(3.) *Fracture of the Great Tuberosity* is an occasional form of fracture of the upper end of the humerus. A double displacement here, also, is produced. The tuberosity is drawn outwards and upwards by the action of the three attached rotator muscles—supra-spinatus, infra-spinatus, and teres minor—this portion of the bone being found under and outside the acromion. The head of the humerus is rotated inwards by the sub-scapularis muscle acting on the small tuberosity; it lies on the inner edge of the glenoid cavity, and under the coracoid process. Or, a partial dislocation backwards may take place, on to the dorsum of the scapula, with a splitting fracture of the acromion process (Fig. 222); this complicated injury arising from the direct violence which knocks off the great tuberosity of the humerus.

Fig. 222.*

Signs.—Deformity of the shoulder, corresponding to these displacements, is always conspicuous. Marked flattening and great breadth of the shoulder, even to double its natural breadth, catch the eye at once. A double projection may be felt—an outer, the tuberosity; an inner, the head of the bone; both, however, lying nearly on the same plane *horizontally*, and with an intervening sulcus or hollow below the acromion. Thus distinguished from fracture of the surgical neck by the position of the fragments, fracture of the great tuberosity somewhat resembles dislocation of the shoulder, by its sub-acromial depression; and, indeed, partial dislocation *forwards* might be said to have taken place. But the presence of *two* osseous projections is distinctive as to the nature of the injury. In the rare form of fracture with partial dislocation *backwards*, the double osseous projection would be wanting. In either case, there will be crepitus on approximating the two portions of bone, and mobility of the tuberosity.

Causes.—*Direct* violence is, mostly, the cause of fracture of the upper end of the humerus. Thus, a heavy fall on the shoulder may occasion fracture of the anatomical or surgical neck, or of the great tuberosity. Protected, however, by the cushion of the deltoid muscle, these fractures are not common, and the first and last are rare. Age seems to favour the occurrence of fracture in the two first-named parts; the anatomical neck being broken more frequently in youth, although possibly at any period of life; while the surgical neck giving way at the epiphysis is an accident peculiar to a period from infancy to about the twentieth year.

Treatment.—These three forms of fracture of the upper end of the humerus may be treated alike, and with successful results. The fragments having been adjusted by extension of the arm, a pad should be placed in the axilla, so as to prevent any re-displacement inwards;

* Univ. Coll. Mus., 103. Fracture of great tuberosity of humerus, and of the acromion, with partial dislocation on the *dorsum* of the scapula.

a shoulder-splint of gutta-percha or pasteboard is moulded to the shoulder and arm, both of which are then secured to the chest by a bandage, and the forearm rested in a sling, without raising the elbow, its weight tending favourably to prevent the recurrence of displacement upward. (Fig. 223.)

Union may not take place in fracture of the anatomical neck, or ligamentous only, or perhaps even a false-joint forms, if the neck be detached completely within the capsule. Sometimes, the head remaining as a foreign body, it undergoes partial absorption—as shown by Gibson; or it may induce inflammation and suppuration, resulting in its extrusion, or necessitating removal surgically. Impacted fracture is apt to unite by bone, with the formation of an exuberant osteophytic deposit around the head.

Fig. 223.

Compound Fracture of the Upper End of the Humerus.—Often comminuted, and with great contusion of the soft parts, this condition of injury occurs only from gunshot wound of the shoulder, involving probably the adjoining glenoid cavity, or the processes of the scapula, or the axillary vessels and plexus of nerves.

Treatment. — Excision may be performed, when the injury is restricted to the head of the humerus, with, perhaps, splintering of the glenoid cavity or scapular processes; and the best results have followed this operation in such cases. Amputation must be resorted to in any additional injuries to the vessels and nerves.

FRACTURE OF THE SHAFT OF THE HUMERUS.—(1.) *Below the insertion of the three muscles into the bicipital groove, and above the insertion of the Deltoid.*—Fracture in this portion of the shaft differs only from that of the surgical neck, in the relative displacement of the two portions of bone. The *upper* portion is drawn inwards, by the three muscles inserted into the bicipital groove; the *lower* portion outwards and upwards, by the deltoid muscle, and in the latter direction especially if the fracture be oblique.

The *Signs* also, thence arising, differ accordingly. Thus, deformity of the arm is presented, corresponding to these displacements, and consisting of two projections—an upper and a lower—but the upper will be felt on the *inner* side, the lower on the *outer* side, of the arm. Mobility of the fragments is very perceptible, giving a hinge-like motion to the arm on the gentlest handling, and crepitus can be readily elicited by extension and rotation; inclination of the humerus *outwards*, with some shortening of the arm, are equally conspicuous; and although the pain of manipulation may be less, the powerlessness is not less complete, than in fracture of the surgical neck. In a case, recently under my care, of fracture of the shaft just above the deltoid, all these signs and symptoms were well pronounced.

(2.) *Below the insertion of the Deltoid.*—Fracture in this portion of the shaft differs only from that above the deltoid, in the relative displacement of the two portions of bone, which are here reversed. The *lower* portion is drawn inwards and upwards, by the flexor

muscles; and the more so in proportion to the obliquity of the fracture from above diagonally across the bone. The *upper* fragment may be slightly everted. A projection, corresponding to the lower end, is most perceptible on the inner aspect of the arm; with an inward inclination of the humerus. The other signs and symptoms—mobility, crepitus, shortening, pain, and powerlessness—are similar to those of fracture above the insertion of the deltoid.

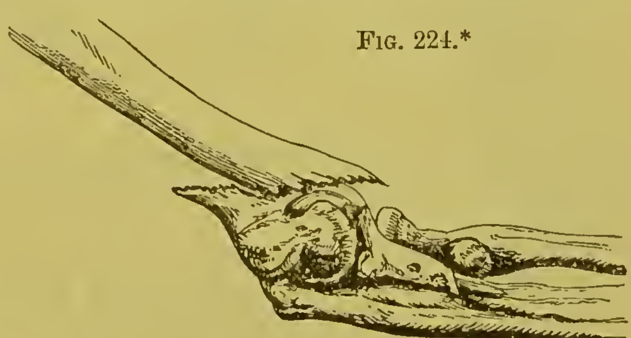
Causes.—Violence, directly or indirectly applied, is generally the cause of fracture in both these portions of the shaft. Powerful muscular action has, however, been known to occasion fracture, usually transverse, and without displacement.

Treatment.—The ends of bone having been adjusted by gentle extension, three or four splints should be applied, so as to nearly surround the arm, and then be retained in position by a bandage. Bandaging the hand and forearm will, as usual, be a proper precaution against œdema; and a sling is used to suspend the forearm, not to elevate the elbow, which, hanging down, tends to prevent the recurrence of displacement. Lonsdale's extension-apparatus is one of the many contrivances which have been devised to maintain extension in fracture of the humerus. It consists of a shaft surmounted by a crutch for the axilla, and which is worked by a screw acting on a vertical slide, the lower end of the shaft being curved to receive the elbow. I have had no experience of the use of this instrument. Malgaigne observes that permanent extension is a resource always dangerous, often useless, and which demands in its application much caution and watchfulness.

Union by bone is the common result, although both Malgaigne and Hamilton concur in the greater relative frequency of fibrous or of non-union than after fracture of the shaft of any other bone. Generally there remains slight overlapping or angular deformity outwards. This will be proportionate to the obliquity of the fracture, or when comminuted; such displacement will be inevitable, however careful may have been the surgical management of the injury.

FRACTURE OF THE LOWER ARTICULAR END OF THE HUMERUS.—(1.) *Transverse Fracture of the Lower End.*—*Supra-condyloid Fracture.*—In this fracture, considerable displacement of the lower or articular fragment backwards, carrying with it the forearm, is produced by the action of the triceps muscle; and a corresponding displacement forwards of the lower end of the shaft of the humerus. (Fig. 224.)

FIG. 224.*



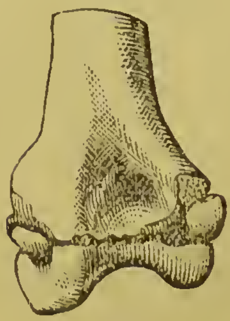
The deformity, therefore, consists of a projection posteriorly and anteriorly, which resembles dislocation of both bones of the forearm backwards; but the mobility and crepitus, on extending the forearm, and return of the displacement on relaxation, distinguish these two forms of injury—*fracture* of the humerus transversely, near the elbow-joint, and *dislocation* of both bones of the forearm backwards. Their diagnosis is obviously most important.

* A. Cooper.

Fracture in this situation happens more frequently in adults, though still only occasionally.

(2.) *Separation of the Lower Epiphysis.*—The same displacement occurs, and attended with the same *signs*; the diagnosis from that of dislocation of the fore-arm backwards is also similar. But the crepitus is less marked than in fracture, owing to the surfaces being cartilaginous at the line of disunion; and thus this injury more nearly simulates dislocation. The mobility, however, is distinctive.

Fig. 225.*



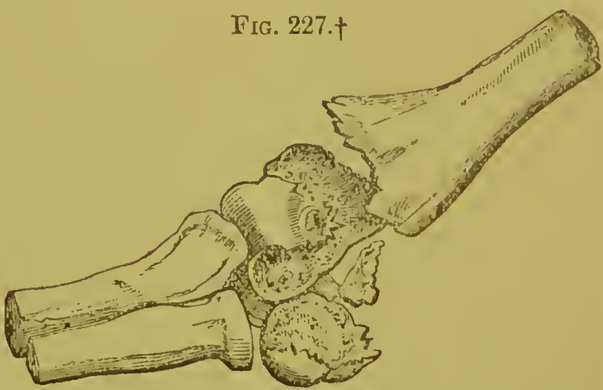
This injury happens only in children, and not uncommonly. (Fig. 225.) Before ossific consolidation has taken place, fracture can hardly occur just above the joint.

(3.) *Fracture of either Condyle.*—The external or the internal condyle of the humerus may be fractured obliquely outwards, or inwards, and extending into the elbow-joint, thus completely separating the condyle. Or, again, a vertical fracture may extend from the joint upwards, bounded by a transverse fracture through the bone, thus separating *both* condyles, as occurred in a case of mine at the Royal Free Hospital. (Fig. 226.) Fracture of either condyle may be associated with fracture above the condyles. (Fig. 227.)

With *single* fracture, there is not much displacement; but on taking

Fig. 226.

Fig. 227.†



hold of the process between the thumb and finger, it can be moved backwards and forwards, with crepitation; the forearm is flexed and, perhaps, supine.

With *double* fracture, there is more displacement, and especially when the condyles are separated by pressure in the longitudinal fracture; the condyles are freely movable, with distinct crepitation; the forearm is flexed and, generally, in a state of pronation.

Contusion, with considerable pain and swelling, usually accompanies these fractures in the vicinity of the elbow; and particularly fracture of either, or both, condyles.

Causes.—*Direct* violence, as by a heavy blow or fall on the elbow,

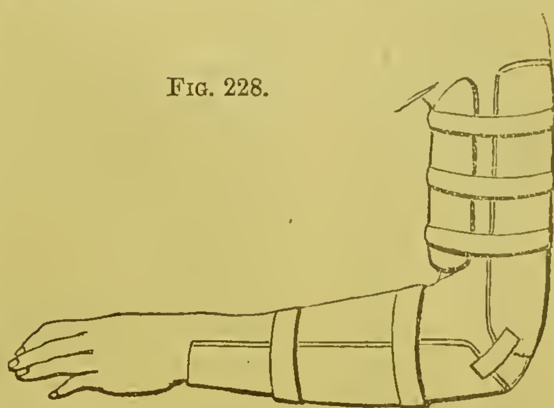
* St. George's Hosp. Mus., 252. † St. Bartholomew's Hosp. Mus., C. 141.

is generally the occasion of fracture, and of the condyles in particular. Separation of the articular epiphysis, or of either condyloid epiphysis, is liable to occur only in infancy or childhood. *Muscular action* has been said to produce condyloid fracture occasionally, especially of the internal condyle, to which the powerful flexor muscles are attached.

Treatment.—The swelling which speedily ensues in these fractures must be subdued, by placing the arm at rest on a pillow, and applying cold lotions, or irrigation. A bottle containing ice-cold water or lotion, with a skein of cotton in the fluid, and hanging out of the neck, forms a simple and effective contrivance. Suspended over the elbow, a constant dropping irrigation can thus be maintained.

Any displacement having been corrected, the bones are best kept in position by angular splints, which well support the lower end of the humerus, and the upper part of the forearm, itself supported in a sling; and thus the patient is allowed to move about. (Fig. 228.) At the end of a month or so, passive motion of the elbow-joint may be advisable, as a precaution against any tendency to anchylosis. Osseous union generally takes place in all these fractures,—supra-condyloid and condyloid. After fracture above the condyles some amount of shortening—under an inch—and consequent deformity are apt to result, even with the most careful management. Condyloid fracture I have known to result in a twisting displacement, forwards or backwards, according to the direction of muscular action.

Fig. 228.



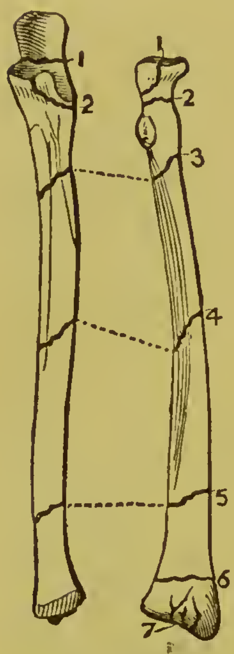
Paralysis is apt to occur in connection with fracture of the shaft of the humerus, involving the *musculo-spiral* nerve as it turns in the groove, downwards and outwards on the posterior aspect of the shaft. Or, if not occurring at the time of the injury, some paralytic symptoms may result from compression of the nerve by ensheathing callus. The extent of the paralysis will depend on the situation of the nerve-lesion, as affecting different sets of muscles supplied by the musculo-spiral. Thus, when the trunk of the nerve is injured, the forearm can be only partly supinated, and there is no power of extending the hand and fingers. The position the forearm assumes is that of pronation, with the hand pendant, or a characteristic *wrist-drop.* This attitude is seen also in connection with lead colic, but the cause of the paralysis will be distinctive in either case. Lower down in the course of the nerve-trunk, as at the elbow-joint, fracture of the external condyle of the humerus may implicate the posterior interosseous branch, leaving the radial branch, as the source of supply to the long supinator and long extensor muscles of the radius and the wrist. Hence some power of supination and extension of the wrist is retained. But the fingers remain flexed. The hand having been subjected to the tonic contraction of the flexor muscles, at last becomes cramped up and crippled, into a *club-hand;* so as to resemble the

deformity resulting from tenosynovitis or from contraction of the palmar fascia. But the rigid flexor tendons or processes of the fascia, in the palm of the hand, are not found in the paralytic condition; and the causes of those affections are also very different.

In the *treatment* of wrist-drop, and of the paralytic club-hand, a palmar splint should be applied, to counteract the tendency to permanent contraction and deformity; and the restoration of nerve power may be promoted by the galvanic current. But its influence will have little effect when the nerve-lesion is nearly complete. When an exuberant callus can be felt anywhere in the course of the musculo-spiral nerve, a portion of the bony clasp may be removed so as to disengage the nerve; and this operation of excision has been followed by the cure or relief of the paralytic affection, in a few instances.

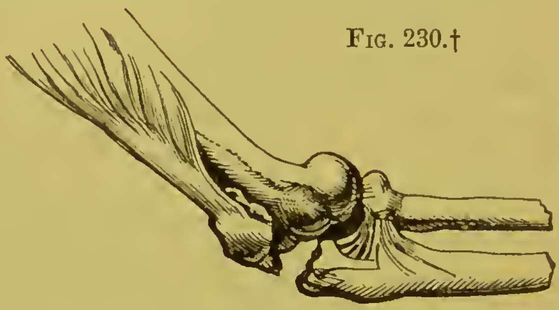
FRACTURES OF THE FOREARM.—The Radius and Ulna are each, singly or conjointly, liable to fracture, in the various situations here delineated. (Fig. 229.)—

FIG. 229.*



1. FRACTURES OF THE ULNA.—(1.) *The Olecranon.*—Transverse fracture not unfrequently occurs, with displacement upwards by the action of the triceps muscle, and which varies in extent according to the

FIG. 230.†



complete or partial rupture of the tendinous expansion of this muscle. (Fig. 230.) An interval between the fragments is thus presented; and the forearm being partly flexed by the unopposed action of the flexor muscles, that interval is increased. Mobility of the olecranon, and some crepitation, easily produced when the arm is extended, will further indicate the nature of the injury. Considerable fluid swelling over the seat of injury may, however, soon render these signs somewhat obscure.

Causes.—*Direct* violence, as a smart blow with a stick, or a fall on the elbow, is the usual occasion of this fracture; and of the contusion which then accompanies it. But a powerful action of the triceps muscle will, sometimes, snap off the olecranon.

Union by ligament ensues in most cases; the length of this band

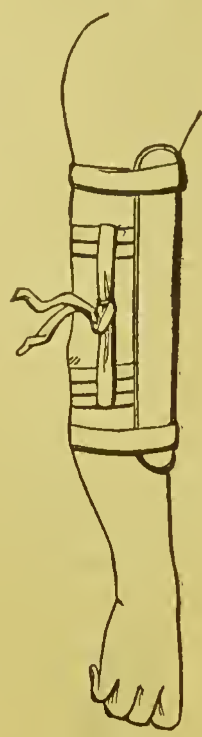
* Fractures of Radius and Ulna. Diagram showing situations and lines of fracture; chiefly from specimens in the Museum of St. Bartholomew's Hospital.—*Radius.*—1. Through head, longitudinal (St. George's Mus., 1, 111). 2. Through neck, transverse (Mütter). 3. Upper third, both bones. 4. Middle third, both bones. 5. Lower third, both bones. 6. Carpal end, or Colles' fracture. 7. Ditto, comminuted into wrist-joint (St. George's Mus., 103).—*Ulna.*—1. Through olecranon, transverse (St. George's Mus., 1, 111). 2. Through coronoid process, transverse (St. George's Mus., 1, 111). 3, 4, 5, as in radius. (Author.)

† After Liston.

varying from a line to an inch or more. Bony union may form when the olecranon is in perfect apposition; yet not always, even in such cases.

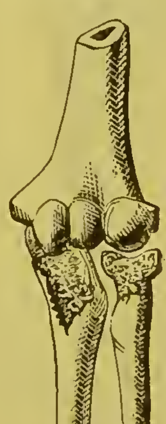
Treatment.—The displacement is reduced by a completely extended position of the forearm; and maintained by means of a splint applied in front of the elbow-joint, passing some distance along the arm and forearm. (Fig. 231.) This position of complete extension has been employed by a large majority of English and American Surgeons, ever since Sir Astley Cooper urged its most obvious advantages. A slightly flexed position was advocated by Boyer and Desault, and is still preferred by most French Surgeons; chiefly on the ground that this attitude of the arm will be most convenient in the event of anchylosis. But the rarity of permanent anchylosis after simple fracture, properly treated, whether by the flexed or straight position, overrules this consideration; and the loss of power almost inevitably consequent on the length of ligamentous union in flexure of the joint, is a result of more serious consideration.

Fig. 231.



(2.) *Fracture of the Coronoid Process.*—Only nine cases are on record—according to Hamilton—in which the *symptoms* were, apparently, referable to fracture of the coronoid process of the ulna; and not one of these cases was established by dissection, actually demonstrating the existence of fracture, opportunity not having permitted of this conclusive evidence. Only four *specimens*—according to the same authority—are known, illustrative, apparently, of this injury; and these are of doubtful character. Fracture of the coronoid process has, generally, been supposed to co-exist with dislocation of the ulna, or of both bones of the forearm, backwards; yet there are only *two* examples in which I have found this fracture in connection with such dislocation of the ulna and radius. (Fig. 232.)

Fig. 232.*



Signs.—The signs of an injury, the pathology of which is thus obscure, must necessarily be little known with certainty. As associated with dislocation, the signs of that form of injury will be present; and, probably, more prominently than those of fracture. Re-dislocation is apt to take place, when extension of the forearm is discontinued; and this sign has been regarded as diagnostic. It may be so, perhaps, in fracture of the coronoid process with dislocation of the ulna *alone*. Pertaining to fracture, there will be some displacement of the coronoid process upwards by the action of the brachialis anticus, if the fracture be situated at the *base* of the process, or beyond the insertion of this muscle.

* St. George's Hospital Museum, 1, 111. A precisely similar form of injury exists in 1, 112, which occurred in the same person, a man aged 26, who fell from a height on both elbows. Another very remarkable and perhaps unique fracture co-exists with the coronoid fracture in *both* the specimens—a fracture, longitudinally, through the *head* of the *radius*.

Fracture of the tip of the process would not be attended with displacement. Mobility of the process, and crepitation, in the bend of the elbow, will confirm the diagnosis.

Causes.—*External violence* is probably the only cause of this fracture. Direct violence, as crushing injuries of the elbow, will, of course, break the coronoid process, or any other part of the elbow-joint exposed to such force; but indirect force, as a fall on the palm of the hand, may possibly fracture the process in conjunction with dislocation backwards. *Muscular action*—that of the brachialis anticus—is commonly regarded as being sometimes the occasion of fracture: but the accuracy of this received opinion is doubtful; Hamilton even alleging that there is no evidence of the coronoid process having ever been broken by muscular action.

Ligamentous union seems to be the mode of reparation; and in the case dissected by Sir A. Cooper, the band was so long and flexible as to allow the fragment to move upwards and downwards in the motions of flexion and extension. Bony union may occur; but, perhaps, only in fracture at the base of the process, and if, fortunately, it be unaccompanied with much displacement.

Treatment.—Flexure of the forearm to a right-angle is the most favourable position for union. This position may be retained by means of an angular splint, and the forearm carried in a sling, for about ten days; care being taken to prevent anchylosis by timely removal of the splint, and use of the sling alone for two or three weeks more. It has been recommended to continue the splint for a longer period; Sir A. Cooper keeping the limb immovable for three weeks, and Velpeau extending this period to four weeks.

FIG. 233.*

Compound and Comminuted Fractures of the Elbow-joint.—The bones which enter into the formation of this joint are liable to fracture, severally, or in conjunction. The olecranon—exposed to external violence—is more often broken, and perhaps also the coronoid process, with the adjoining portion of the shafts of the ulna (Fig. 233); or perhaps the articular end, or the epiphysis of the humerus; or one or both condyles. (See Figs. 226, 227.) The bones are comminuted, often extensively, and with contusion rather than laceration of the integuments. The injured joint feels like a bag of bones, crepitating under manipulation, or movements of the joint, which is singularly loose and movable. One or two trifling wounds, at the back of the elbow, or near the condyles, communicate with this disorganized state of the joint; which results from *direct* violence. More extensive laceration of the soft parts accompanies the fracture, when occasioned by gunshot wound.

* St. George's Hospital Mus., iii. 13. Fracture of the olecranon, transversely, and of the adjoining portion of the shaft of the ulna, by comminution, detaching the coronoid process through the sigmoid cavity of the bone. These injuries were caused by direct violence—a blow from a falling beam. Amputation in the arm was followed by recovery. On examining the joint, the articular cartilages and synovial membrane were found to be diseased; the latter in the form of tufty pendulous growths, and a loose cartilage dropped out, produced apparently by growth of one of the tufts connected with the synovial membrane. See also *Lancet*, 1850, vol. i.

Treatment.—Preservation of the limb, excision, or amputation, either of which operations may be performed primarily or secondarily, have severally to be considered, as indications of treatment.

Compound fracture, alone, without comminution, or much laceration of the soft parts, will allow the opportunity, at least, of preservation of the limb.

Comminution to even a considerable extent, without much injury to the soft parts, permits excision of the disorganized joint; or this operative procedure may become necessary in the event of profuse suppuration or sloughing, after either of these conditions of fracture.

Extensive contusion or laceration of the soft parts, in conjunction with comminution of the bones, demands amputation; or this operation will, in its turn, be unavoidable after failure of excision.

It must be confessed, at least with regard to my own experience, that the results of treatment in these conditions of injury to the elbow-joint are seldom successful as compared with similar treatment for *disease* affecting this joint. With compound fracture, I have seldom succeeded in preserving the limb; and the failure of any attempt has been owing in this—as in similar injuries of the joints and limbs by direct violence—to the extensive subcutaneous destruction of texture, concealed probably by an almost apparently uninjured state of the integument. Pathological anatomy—as shown by dissection—has corrected the shortcomings of clinical observation.

FIG. 234.*

FIG. 235.†

2. FRACTURE OF THE SHAFTS OF THE RADIUS AND ULNA.—Commonly occurring in the middle (Fig. 234) of the forearm or below (Fig. 235), and rarely above, fractures of the forearm may be limited to either bone alone—ulna or radius, or involve both bones. Usually broken transversely or obliquely, and occasionally comminuted, the displacement generally is anterior, owing to the greater power of the flexor muscles; sometimes, however, posterior, lateral or angular. (Fig. 234.) Fracture of the *radius* alone is attended with a tilting forwards of the upper portion of the shaft by the joint action of the biceps and pronator radii teres muscles, while the lower portion is drawn inwards towards the ulna by the supinator longus and pronator quadratus. (Fig. 236.)

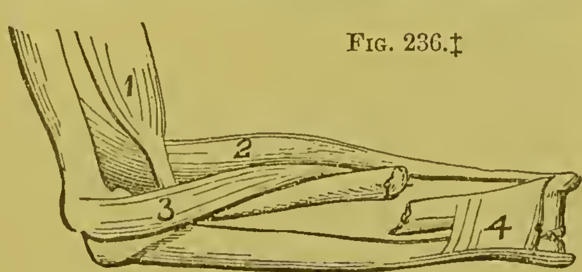


FIG. 236.‡

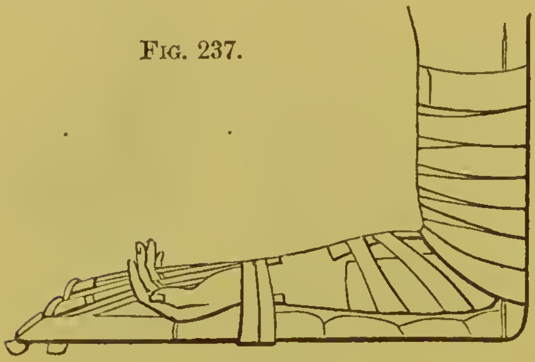
* St. Bartholomew's Hosp., C. 128. † St. George's Hosp., 1, 92. ‡ Gray.

The usual *Signs* of Fracture are present. Deformity at the seat of fracture, corresponding to the displacement; mobility, crepitus, shortening, with some alteration in the direction of the axis of the bones, or forearm below the fracture; pain, and inability to use the hand, with some loss of pronation and supination, if the radius be broken.

Causes.—Indirect violence is, mostly, the occasion of fracture; as by a fall on the hand. Hence the radius yields more frequently than the ulna. *Direct* violence may sometimes be the cause; the middle or lower portion of the shaft being more liable to be broken than the upper portion, which is protected by a considerable thickness of muscle.

Treatment.—The fractured ends having been adjusted, a pad should be laid along the interosseous space, to prevent any inclination of the bones inwards; as union or ossific deposit across this space would render pronation and supination imperfect or impossible. For this reason also, the forearm should not first be bandaged *under* the splints. A long splint, extending from the bend of the elbow to the fingers, is placed on the inner aspect of the forearm and supporting the hand. A corresponding splint, on the outer side, need reach only to the wrist. Both the splints should be a little broader than the arm, so that, in bandaging, the bones may not be compressed; a roller is then applied from the fingers upward, and the forearm rested in a sling. Inflammation and tense swelling often supervene, leading even to gangrene, and the bandage must be regulated accordingly; a watchful supervision of the treatment being continued for some days. Another method has been devised, and practised with success, by Dr. X. C. Scott, of the Brooklyn City Hospital, U.S. The forearm is placed in the supine position, and retained, with sufficient extension from the wrist, by means of adhesive plaster, with elastic bands; counter-extension being made from above, with the arm at a right-angle as here represented. (Fig. 237.) In twenty-five cases successful results have been obtained. This method certainly claims two advantages: the supine position prevents the risk of union taking place between the bones, across the interosseous space, owing to the tendency to pronation; and by the maintenance of extension, the tendency to displacement upwards, by the action of the flexor muscles, is overcome.

FIG. 237.



Compound Fracture of the Forearm.—Usually arising from *direct* violence, there may be far more extensive disorganization subcutaneously, than appears from the comparatively uninjured integument. The question of amputation will be guided, mainly, by this consideration. Otherwise, operative interference should be postponed pending the natural tendency of the injury either to recovery, or to suppurative destruction or gangrene of the limb. This latter issue is far less frequent than in similar injury of the leg; and *secondary* amputation can then be had recourse to.

3. (1.) FRACTURE OF THE LOWER END OF THE RADIUS.—Known as

Colles' fracture, when situated just above the articular surface, this fracture is generally transverse; sometimes comminuted, or impacted. Displacement of both fragments occurrs. (Fig. 238.) The lower or articular fragment is displaced backwards and upwards, and slightly

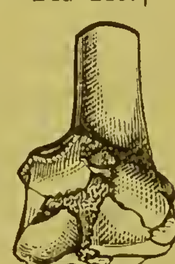
Fig. 238.*

outwards, with some degree of similar rotation on its horizontal axis; this fragment being drawn in these directions by the action of the two radial extensors of the wrist, the three extensors of the thumb, and by the supinator longus muscle; or similar displacement with impaction may arise from the direction of the force of fracture, when caused by a fall on the palm of the hand. The upper fragment is pronated by the pronator quadratus and teres muscles. According to Nélaton's observations, the styloid process of the ulna is often broken, and the triangular ligament torn, in connection with this fracture of the radius.

The *Signs* of Colles' fracture resemble those of fracture in general, but have certain characteristics in this situation. A prominence to be seen and felt at the back of the wrist, just above the joint, corresponds to the *lower* or articular fragment; immediately above which, a depression corresponds to the somewhat depressed upper end of the fracture. (Fig. 239.) The palmar aspect of the forearm, just above the wrist, presents the opposite appearances: a marked hollow underneath the articularfragment; andimmediately above, the prominence of the *upper* fragment-end, pronated by the pronator muscles, and bulging the tendons of the flexor muscles. These appearances are, of course, more marked on, or perhaps restricted to, the radial side of the forearm; and they are most conspicuous when the forearm is viewed laterally. The hand is prone, and drawn downwards and, pronely, inwards; presenting a concavity on the radial side of the wrist, and a convexity on the ulnar side, the styloid process of the ulna projecting under the integument. Mobility of the radius above the fracture, the lower fragment not moving with it, and crepitus, both of which are elicited on rotating the bone; pain, and dropping powerlessness of the

Fig. 239.

Fig 240.†



* Univ. Coll. Mus., 211.

† St. George's Hospital Museum, 1, 103. Comminuted fracture of the lower articular surface and extremity of the radius. The fragments are very much displaced, particularly at the posterior margin of the bone; but bony union has occurred by new osseous deposit between the contiguous edges of the fragments. The injury was produced by a fall on the hand, from a height of about 20 ft.; and death took place eleven weeks after the accident. The carpal end of the other radius was fractured in like manner; this double fracture showing that the weight of the body must have been received equally by both hands.

hand, with loss of pronation and supination; supply additional signs and symptoms, which further manifest the nature of the injury.

Comminution of the lower or articular fragment (Fig. 240) will render some of these signs more perceptible; mobility and crepitus, in particular.

Impaction of the upper into the lower fragment would render the two latter signs imperceptible, more or less entirely, according to the firmness of the impaction.

Separation of the radial *epiphysis* must be a very rare form of injury. I know of only two instances in which it has been verified by dissection. One specimen—marked 1, 94 (Fig. 241)—is preserved in the collection of St. George's Hospital. The other is in the Museum of St. Mary's Hospital; and this is especially valuable, as showing an arrested growth of the shaft of the radius, to an inch less in length, as compared with the ulna, consequent on the loss of the epiphyseal growth of the radius.

Fig. 241.

Fracture of the lower end of the *ulna, with* that of the radius, simulates dislocation of the wrist backwards. Mobility of the carpal fragments in connection with any movements of the hand, and crepitus, are diagnostic of this double fracture in the vicinity of the wrist-joint.

Causes.—*Indirect* violence, by a fall on the *palm* of the hand, is the usual mode of fracture, thereby breaking the radius transversely within an inch above its articular surface, perhaps also comminuting this fragment; or allowing the upper fragment-end to be driven into, and impacted in it. A fall on the *back* of the hand may cause a similar fracture, but throw the lower fragment forwards instead of backwards. Such a displacement is described by Robert Smith as having been met with in one case, and Hamilton has seen another case; neither, however, were verified, as to their pathological condition, by dissection; nor is there —observes the latter authority—to be found one such specimen in any of the pathological collections in Dublin. Colles' fracture may also, it is said, be occasioned by *direct* violence. I am not acquainted with any such case.

Treatment.—Reduction of the displacement often requires considerable extension and counter-extension to effect it satisfactorily, not to say completely. Many forms of splint or retentive apparatus have been contrived. Two splints are commonly used: a long, curved, or pistol-shaped splint (Fig. 242), extending from the elbow to the fingers, whereby the hand can be well drawn downwards to the *ulnar* side; and a short, straight splint, extending from the elbow only to the wrist. These splints may be applied—the one along the palmar surface of the forearm and hand, and the other to the dorsal surface of the forearm; or in the opposite arrangement.

Fig. 242.

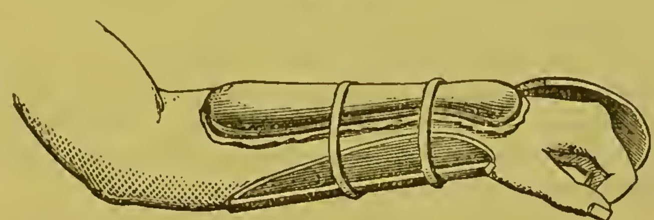
Of these two plans, I prefer the former. Thus, the pistol-shaped

splint, applied from the bend of the elbow along the forearm, need only extend to the fingers; and bending them over a pad at the end of the splint, gives a flexed position to the hand which is easy and comfortable. A pad corresponding to the line of the radius, betwixt the splint and forearm, will further prevent any tendency to pronation of the upper fragment; while the curved shape of the lower end of the splint, inclining the hand to the ulnar side, corrects the displacement of the lower fragment. The short, straight splint applied to the dorsal surface of the forearm, from the elbow to the wrist, affords a counter-support; and with a pad between it and the lower fragment, *directly* prevents the displacement of this portion of the bone. The splints are bandaged from below; the hand to the curved portion of the long palmar splint, and the roller being continued upwards around both splints to the elbow. The forearm is then rested in a sling. Much inflammation and swelling speedily ensue in this fracture, suggesting a watchful regulation of the bandage. In one case—a woman about thirty, but who had drank hard—spreading (traumatic) gangrene speedily ensued, and passing up rapidly towards the shoulder, compelled me to amputate there. The patient made a good recovery.

The opposite arrangement is Nélaton's plan of applying these splints. The pistol-shaped splint, placed on the *dorsal* surface of the forearm, extends from the elbow along the fingers; and the open hand is thus inclined by the curved portion of the splint to the ulnar side, correcting the displacement of the lower fragment. The straight, short splint, placed on the palmar surface of the forearm, extending to the wrist or only to the end of the upper fragment, and padded along its radial border, specially tends to prevent pronation of the upper fragment. A bandage is then applied as already described; and the forearm rested in a sling.

Gordon's splint may be used with advantage, for correcting the displacement, when Colles' fracture cannot otherwise be kept reduced. This splint consists of two pieces: an anterior, which is provided with a hollow receptacle for the outer side of the hand, and a posterior splint, which reaches over the back of the wrist. The fracture having been reduced, and the hand placed in the prone position, the splints applied appear thus (Fig. 243); being retained by a couple of buckling bands. Any displacement of the upper end of the radius is controlled by the anterior splint; while the hand dropping over the end of this splint, raises the lower or carpal fragment to a level with the upper end. I have not hitherto had occasion to use Gordon's splint preferably to the ordinary pistol-shaped splint; and when I have not used the latter, a double *straight* splint, the posterior extending to the end of the fingers, while the anterior just catches the carpal fragment, has answered remarkably well; the resulting deformity being no more than almost invariably remains after any method of adjusting Colles' fracture.

Fig. 243.



Union ensues in about a month, but rarely without some displace-

ment; thickening and stiffness also remaining for a considerable period. Passive motion and friction should be resorted to, in anticipation of this result. Some deformity remains permanently, except in rarely perfect results.

Separation of the lower *epiphysis* of the radius has occurred in youth; an injury simulating fracture, and requiring the same treatment.

(2.) *Fracture* through the *Head* of the *Radius*, occurring alone, has, I believe, never been met with. In conjunction with fracture of the coronoid process of the ulna, and dislocation of both bones backwards, this form of injury has occurred in two instances, one of which I have represented. (See Fig. 232.)

(3.) *Fracture* of the *Neck of the Radius.*—This injury, uncomplicated with any other fracture or dislocation, must be exceedingly rare. Sir A. Cooper doubted its existence, and Hamilton adduces only one apparently certain instance—a specimen of Dr. Mütter's. As accompanied with fracture of the coronoid process of the ulna, Velpeau and Bérard have each contributed a case of this radial fracture, verified by dissection. But I allude to this form of injury, rather to guard against any error of diagnosis. The upper end of the lower fragment of the radius would probably be displaced forwards by the action of the biceps muscle, inserted into the tubercle, and extension of the arm would increase this displacement. Mobility and crepitus will be more or less perceptible, with flexion of the forearm, and loss of pronation and supination.

Treatment should consist in a flexed position of the forearm upon the arm to relax the biceps, the application of a compress over the abutting lower fragment, and a dorsal splint; the whole being secured by a roller-bandage, and rested in a sling.

FRACTURE OF THE CARPAL, METACARPAL BONES, AND FINGERS.—*Simple* and *Compound* Fractures of these bones may occur; and with the usual signs of such Injuries. Direct violence is perhaps their most frequent cause; but indirect force may also be the occasion of fracture, as by a blow given with, or received upon, the fist. Union generally results in some deformity, yet without much impairing the use of the part.

The *treatment* will consist in the adjustment of the fragments, and their retention in position upon a gutta-percha or pasteboard splint, contrived according to the fracture.

Compound fracture may require excision or amputation. But the removal of only the injured portion of the hand should ever guide and regulate any operative interference; the hand being a most valuable member in each of its several parts, and readily recovering from most injuries.

FRACTURES OF THE PELVIS.—(1.) FRACTURE OF THE INNOMINATE BONES. —*Structural Conditions.*—Commonly, the *rami* of the pubis and ischium are the seat of fracture (Fig. 244); sometimes, the line of fracture passes from above the acetabulum across the *ilium*, in various directions. (Fig. 244); or it may involve the *acetabulum*, fissuring its floor (Fig. 244), or fracturing its margin (Fig. 244). Sometimes the acetabulum is comminuted, or simply divided into its three original segments, and the head of the femur driven into the pelvic cavity (Fig. 244); or a portion of the *margin* being detached, dislocation backwards takes place. In one case, I found the pubic portion of the acetabulum nearly detached, and another fracture at

the junction of the descending ramus of the pubis with the ramus of the ischium; thus nearly isolating the pubic bone. The preparation is in the Museum of the Hospital.

FIG. 244.*

Occasionally, some other; and perhaps any portion, of these bones may be broken; as, for example, a rim-like piece of the *crest* of the ilium, or the *tuberosity* of the ischium. Both innominate bones are not unfrequently fractured, and somewhat symmetrically; as, corresponding portions of the rami of the pubis and ischium.

Separation of the *symphysis* pubis, or of either *sacro-iliac articulation*, rarely takes place. I have, however, met with this injury to each of these *three* articulations in the same person; but only once.

Little or no displacement is liable to occur, otherwise than by muscular action; the bones being well held together, and cushioned by soft parts. But the pelvic viscera are frequently injured; rupture of the bladder and urethra, giving rise to extravasation of urine; laceration of the rectum sometimes occurring; or of the larger blood-vessels, with intra-pelvic hæmorrhage. These visceral or internal injuries are of far more serious import than the fracture in itself. Fractures of the pelvis thus have an *analogous* resemblance to those of the ribs and sternum, and of the cranium or vertebral column, in regard to their visceral relations.

The *Signs* of fracture of the innominate bones are not peculiar. No irregularity of the bone at the seat of injury may be discovered; but mobility and crepitus, on moving each half of the pelvis backwards and forwards, will be readily perceptible; while the ischium is best examined by the finger in the rectum or vagina, with external manipulation of the tuberosity, or by then flexing or extending the thigh; pain also and inability to support the trunk are experienced by the patient on attempting to move or stand up. Inability to empty the bladder, or bloody urine, denotes some injury to this organ; and occurring with the accident, confirms the diagnosis. Caution, therefore, should always be observed in handling the pelvis, lest any visceral injury be aggravated. Fracture of, or involving, the *acetabulum* is indicated by the crepitus elicitated on rotating the femur, with the other hand placed over the trochanter. Detachment of a portion of the *margin*, with dislocation, is characterized by the recurrence of dislocation after its reduction, the head of the femur easily slipping out of the acetabular cavity.

Separation of the *symphysis*, or of the *sacro-iliac articulations*, allows of free mobility, and an interval may even be felt in the situation of such separation. In the case to which I have alluded, I could plainly pass my finger between the symphysis, and so far as to recognize the

* St. Bartholomew's Hospital, C. 40. A fracture has split the acetabulum into four portions, which are widely separated. From this centre, fractures also extend through the body and ramus of the pubis; through the ischium, between its spine and tuberosity; and through the ilium, vertically to its crest, and obliquely to its anterior spine.

flat surface of the body of either pubis covered with its immediate plate of fibro-cartilage. The transverse or connecting fibres had given way, as well as the ligaments on each aspect of the symphysis, including the strong *sub*-pubic ligament.

Causes.—*Direct* violence is almost the only cause of fracture of the pelvis. A heavy fall, or a crushing compression of the innominate bones, as by a cart-wheel passing over the pelvis, or the force of a squeeze between the buffers of two railway carriages; such, and similar accidents, are the ordinary occasions of these injuries; or they result from the equally formidable contusion of gunshot wounds. *Indirect* violence sometimes produces fracture of the pelvis; as of the acetabulum, when a person falls from a height and alights on his feet. Force applied from the back may have the same effect; an instance of which is cited by Hamilton—a man ætat. twenty-seven, on whose back a number of bricks had fallen while his right knee rested on the bank of a trench. Death ensued in a few days; and a fracture was found extending through the bottom of the right acetabulum, and about one inch and a half of the rim at its upper and posterior margin was completely detached, otherwise than as being retained by a portion of the capsular ligament. Dislocation upwards and backwards could be readily reproduced to and fro. The femur was not broken. Falls on the hip, striking the great trochanter, are perhaps the most common occasion of fractured acetabulum; the force then being transmitted more directly.

Course and Terminations.—Union of the fracture takes place generally without difficulty, resulting only in some degree of lameness. This result occurs more frequently in fracture of the acetabulum, with dislocation, owing to the nature of the injury not having been detected, or the impossibility of maintaining reduction. Permanent lameness ensues. But any visceral injuries are of more serious or fatal consequence. The chief difference in such cases depends on the situation of the injury; whether, or not, laceration of the bladder opens into the peritoneal cavity, with extravasation of urine internally or externally. In the one case, death is almost inevitable; in the other, urinary infiltration behind or in front of the deep perineal fascia, will be followed by suppuration and sloughing, perilous to life.

Treatment.—Any *visceral* injury demands immediate attention. A catheter should be introduced to discover the state of the bladder. If bloody urine or other symptoms of injury to this organ or the urethra be present, the catheter must be kept in the bladder, to prevent extravasation of urine. In the event of extravasation externally, early and free incisions into the scrotum may avert the full extent of the local mischief, and the consequent typhoid disorder. But the treatment of such Extravasation of Urine is described in a subsequent chapter. The *fracture* itself requires comparatively little surgical manipulation. The pelvis should be bound round with a broad roller, or rib-bandage, and the patient laid recumbent at rest on a flat bed or mattress, sufficiently firm to counteract any tendency to displacement. The thighs should be flexed upon the abdomen, and supported with pillows under the knees; this position preventing displacement by muscular action, and often proving also the most comfortable. Fracture of the acetabulum must be secured by means of a long splint, or a hip-splint of gutta-percha, moulded to the side of the

pelvis and thigh, to fix the joint. Angular extension is recommended by Dr. Bigelow, who then applies an angular splint, with the limb suspended vertically; or, he observes, if in any manœuvre reduction is effected, the limb should be retained, if possible, in the attitude which completed the manœuvre.

(2.) FRACTURE OF THE SACRUM.—Exceedingly rare, fracture of the sacrum may, however, occur in conjunction with that of the innominate bones. The fracture then takes place at any part of the sacrum, and in any direction; but it may happen independently, and then generally below the sacro-iliac articulation, and transversely across the bone. In this condition, displacement is almost always the same; the coccygeal extremity being driven forwards, without probably interfering with the rectum or anus. A slight lateral deviation is sometimes produced. Far more rarely, the fracture is vertical, or conjoined with a transverse fracture, of which I have found only one instance. (Fig. 245.) One line of fracture passes transversely across the junction of the first and second sacral vertebræ, and communicates with other fractures which detached the upper angles of the first. Another line of fracture passes downwards from the first sacral foramen, on the left side, through the whole length of the body of the sacrum, and the first portion of the coccyx. No union has taken place. The patient, a lad aged eighteen, fell from the top of Holyrood Palace, a height of 76 feet; and in addition to the above injury, there was a compound dislocation of the ankle, with fracture of the astragalus, a dislocation of the humerus, and concussion of the brain. The only sign of the fracture of the sacrum was severe pain in the loins and back. Abscess formed over the sacrum, and communicated with a large intra-pelvic abscess.—Roy. Coll. Surg. Mus., 981; also the "London Medical Gazette," vol. v. p. 508. (R. Liston.)

FIG. 245.

The *Signs* are an angular projection backwards at the line of fracture, and corresponding to the displacement forwards, mobility and some crepitus; with pain, greatly aggravated in any attempt to bend or elevate the body, and especially acute in any efforts at defæcation.

Causes.—Fracture of the Sacrum arises from the same causes as that of the innominate bones; and from blows or falls on the sacrum itself, in fracture transversely below the sacro-iliac articulation.

Course and Termination.—If fracture of the sacrum occur in conjunction with fracture of the innominate bones, the accompanying lesions of the pelvic viscera generally prove fatal. Fracture of the sacrum alone is usually followed by a speedy recovery, although the inward displacement cannot often be completely overcome.

Treatment.—The displacement may be corrected by passing a finger into the rectum and pressing back the coccygeal portion of the sacrum; but great difficulty will often be experienced in retaining it there. Various contrivances have been resorted to for this purpose, such as the introduction of a wooden cylinder, or other form of compress, within the bowel. Any such body must be removed every two or three

days, and an enema administered. The action of the bowels should be rather restrained by opiates, thus to prevent disturbance of the part by daily evacuation; while some accumulation of fæces in the rectum may act as an efficient compress, instead of using any artificial form of rectal plug. I prefer rectal constipation for the purpose of keeping the lower fragment of the sacrum in good position, at least after the first few days, when the impaction of fæces will usually be sufficient to check displacement; and the continued introduction of a foreign body is less tolerable to most patients. A roller drawn firmly round the pelvis, and the support of a flat, resisting mattress, insures the rest requisite for union. This takes place in about a month, or a shorter period, according to the less frequent disturbance of the part by the act of defæcation. Thus, in a case under Bermond's management, the rectal plug was retained without much inconvenience nineteen days, having been only once removed during that period; and union was then firm.

Fig. 246.*

Fracture of the Coccyx is an uncommon accident. The structural condition, signs, causes, and treatment are the same as in fracture of the coccygeal portion of the sacrum. The pain and inconvenience by occlusion of the rectum may be very persistent, after the injury itself is repaired. The sitting posture will then be made more tolerable or comfortable, by wearing a pad on each tuberosity of the ischium. A horseshoe-shaped air-cushion will also give great relief, as I have known in cases of *coccydynia*, a painful or neuralgic affection of the coccyx.

Fractures of the Femur.—Like other long bones, fracture of the thigh-bone may occur, in its Upper Articular end, the Shaft, or the Lower Articular end. (Fig. 246.)

Fractures of the Upper Articular End comprise those of the Neck, within, or outside, the Capsule, and Trochanteric Fractures.

(1.) Intra-capsular Fracture of the Neck of the Femur.—*Structural Conditions.*—In *direction*, intra-capsular fracture of the neck of the femur is, generally, somewhat oblique—from above downwards and outwards, including sometimes a portion of the head; occasionally, it is quite transverse. (Fig. 247.) The *capsule* and *periosteum* are generally rent asunder incompletely, but sometimes completely. *Displacement* of the two fragments usually occurs; the lower fragment,

* Fractures of Femur. Diagram showing situations and lines of fracture; chiefly from specimens in the Museum of St. Bartholomew's Hospital.—1. Intra-capsular. 2. Extra-capsular. 3. Through great trochanter. 4. Inter-trochanteric. 5. Summit of great trochanter, or epiphysis (Middlesex Hosp. Mus., 111, 2). 6. Below trochanters. 7. Upper third. 8. Middle third. 9. Lower third. 10. Supra, and inter-condyloid, into knee-joint (St. Bartholomew's Mus., C. 13). 11. Internal condyle. 12. External condyle. (Author.)

the shaft of the bone, is drawn upwards and to the outer or posterior side of the head of the bone, and rotated so that the fractured end is directed forwards. The upper or articular fragment remains in position; the head of the bone being in the acetabulum, and connected

FIG. 247.*

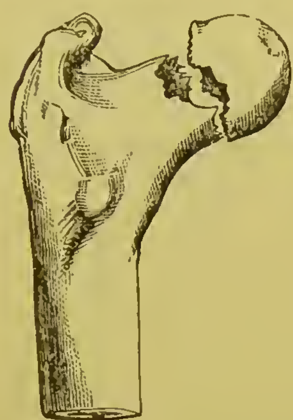
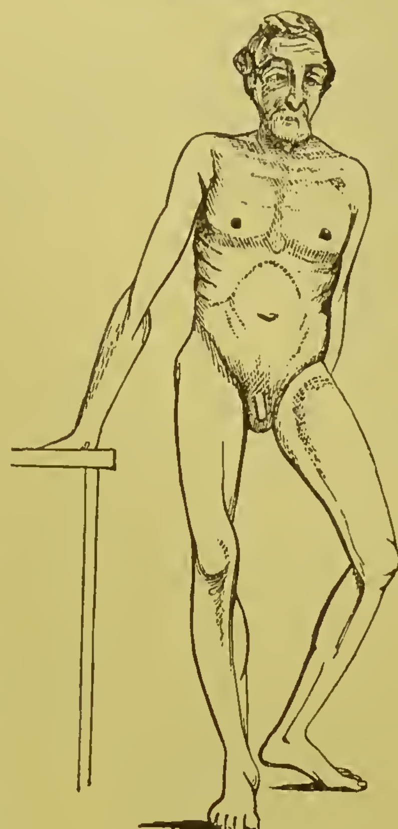


FIG. 248. †



by the round ligament. Displacement of the lower fragment will be more or less complete, according to the extent of rupture of the capsule and periosteum.

Impacted fracture is not very uncommon, in my experience; the end of the lower fragment being driven into the upper.

Signs.—In intra-capsular fracture of the neck of the femur, the limb is shortened, and everted; with the knee slightly flexed, the toes pointing outwards, and the heel drawn up and resting on the inner side of the leg above the ankle. (Fig. 248.) The hip is somewhat flattened, the prominence of the great trochanter being less marked, and drawn upwards to the anterior superior spine of the ilium. Thus far, the injury resembles dislocation forwards upon the pubes; excepting that the limb is then abducted, and the head of the bone can generally be felt in its new position. But, with fracture, on drawing the limb downwards to its proper length, and rotating inwards, crepitus and mobility of the lower fragment will be felt, when the hand is placed over the trochanter; and this prominence of bone moves in a less regular and smaller segment of a circle than on the opposite or sound side. Pain, severe on any attempt at motion, and total powerlessness of the limb, conclude the diagnosis. *Shortening*, in the first instance, varies from half an inch to an inch; but it increases, perhaps, to two inches or more, as the capsular ligament yields more completely, by contraction of the muscles or by bearing on the limb, or if the fragments impacted become dislodged. But shortening of the limb may be produced by slight flexion, as an effort of the patient

* St. Bartholomew's Hospital Museum, C. 113.

† Intra-capsular fracture of neck of Femur. (Author.)

thus to relax the muscles which act upon the hip-joint, in order to relieve the pain in the hip; it may, therefore, indicate simply a sprain of the joint; or it may result from hip-joint disease, former fracture of the thigh or leg, malformation, or arrest of development. Any obliquity of the pelvis will also affect the comparative length of the two limbs. To determine whether shortening be apparent or real, the patient should be laid upon his back, with the pelvis even on either side; then the relative length of the limb can be estimated by observing whether the soles of the feet are in the same plane; but measurement with an inextensible, graduated tape will afford the only exact and conclusive evidence—observing to draw the tape between two fixed points, the anterior superior spinous process of the ilium, and the lower margin of the inner malleolus of the ankle, thus to find the actual length of the limb, as compared with the other side. Possibly, no shortening may take place at first, no displacement having occurred, and this state may continue for a period of some hours, or even for days; on the other hand, considerable shortening may soon be induced by a rough examination of the limb. *Eversion* is produced, partly by the action of the external rotator muscles inserted into the great trochanter, and partly or principally as the natural position into which the lower limb falls when left to itself. *Inversion* sometimes occurs, but very rarely; and is owing, probably, to the action of the adductor muscles, aided by some partial rent of the capsular ligament favouring such muscular action. Thus, if the inner side of the capsule remain entire, this, it has been supposed, would facilitate inversion; but it seems to me that a rent of the inner side of this ligament would be more conducive to inward rotation of the femur. Dissection in cases of inversion is wanted to establish either opinion. An unusual position of the lower fragment, in front of the upper one, is the explanation urged by Dr. R. W. Smith. Neither eversion nor inversion of the foot may be present, according to Hamilton, in some cases; the toes pointing directly forwards.

Impacted fracture is denoted by an absence or minor degree of all the signs, except shortening. Some degree of shortening of the lower limb, which cannot be extended to its original length; unacompanied by the other signs of fracture—or dislocation—and immediately consequent on some occasion of injury, is diagnostic of fracture, with impaction of the fragments,—an impacted fracture. A well-marked case of this kind, which was under my care in the Hospital, is reported in the "Medical Times and Gazette," 1866; and subsequently, I brought forward other cases at the Harveian Society. Eversion, or occasionally inversion, with impacted fracture, may be produced, partly by the causes already mentioned, but specially, perhaps, by the direction and extent of the impaction, giving a turn to the limb one way or the other.

Causes.—*Indirect* violence, but of so slight a character, in many cases, as scarcely to exceed a stumble, will, generally, be found the only external cause to which intra-capsular fracture of the neck of the femur can be referred. A slight trip of the foot, slip, or mis-step in going down stairs, are the usual occasions of this fracture. But *age* very much *predisposes* to the injury. It seldom happens in persons under fifty; and the predisposing condition consists of an alteration in the structure, and consequent direction of the neck of the femur,

thence favouring the occurrence of fracture in this portion of the bone. Its cancellous and compact texture having undergone fatty degeneration, or disintegration and *atrophy* (Fig. 249), the neck

FIG. 249.*

FIG. 250.†

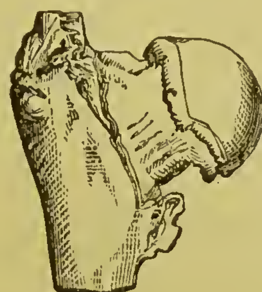


FIG. 251.‡

gradually yields to the weight of the body; the inferior border of the neck, originally the longest, thus becomes somewhat shortened, and the whole neck drops to nearly a *right-angle* with the shaft. (Fig. 250.) This horizontal direction, in particular, renders the neck less able to sustain the shock of any force transmitted through the femur, and which throws the weight of the trunk suddenly on this portion of the bone. It snaps instantly and easily—perhaps, almost imperceptibly.

FIG. 252. §

FIG. 253. ‖

Besides the predisposition of advancing life, intra-capsular fracture of the neck of the femur is said to be more frequent in women than in men. The circumstances of age, and the slight indirect violence, associated with the production of intra-capsular fracture, should be considered, with the signs already mentioned, in aid of the diagnosis.

Union by *ligament* ensues, as the only mode of reparation in most cases (Fig. 251), or when the upper fragment is impacted. (Fig. 252.) Or *no* union may take place, the portion of the neck and head, in the acetabulum, undergo absorption to some extent, while the trochanteric fragment becomes flattened and expanded, apparently as the result of constant pressure and friction; or a false ball-and-socket joint forms between the ends of the two fragments. *Bony* union, at one time and for many years thought never to take place, does assuredly result in some rare cases (Fig. 253); but only, it would seem, when the capsular ligament remains entire, or the fragments are impacted, whereby a due supply of blood can be speedily established.

The use of the limb is not restored under three or four months.

* St. Bart. Hosp. Mus., 1, 206. † Ibid. C. 78. ‡ Ibid. 3, 22.
§ Ibid. 3, 110. ‖ Ibid. 3, 21.

Treatment.—No bony union taking place, as a rule, in intra-capsular fracture of the neck of the femur, it will generally be useless to adjust the fracture and apply any retentive apparatus, with a view to such union; and the more so, in proportion to the years of the patient. In elderly persons, and those to whom any long confinement would be prejudicial, their general health is of more consequence than the fracture, and which is itself irreparable in advanced life.

The limb may be placed in an easy position, until pain, and the inflammatory consequences of the injury have subsided, when a splint moulded to the hip should be applied, and the limb slung from the foot by a long band passing round the neck; the patient thus being enabled to get about on crutches. Whatever reparation, and recovery from lameness, may then take place, it proceeds under the most favourable circumstances with regard to the general health, and its influence on reparation.

In younger subjects, the fracture may be adjusted, and a long splint applied, as for the treatment of other fractures of the femur. Admitting the possibility of bony union, and the uncertainty of diagnosis between intra-capsular and extra-capsular fracture of the neck of the thigh-bone, it is deemed advisable by some Surgeons of experience, not only to abandon Sir A. Cooper's rule of practice—that of treating all supposed intra-capsular fractures without retentive apparatus—but, conversely, to treat all alike by retention, excepting under the special circumstances of advanced age or debility. Otherwise, the Surgeon may fail to obtain bony union and a more useful limb, when he might possibly have gained this end; or he may be misled to neglect the proper treatment, when the fracture is beyond the capsule.

Impacted fracture should be treated in the same way; but the splint is applied only for retention, as the limb cannot be extended to its original length.

(2.) Extra-capsular Fracture of the Neck of the Femur.—*Structural Conditions.*—In *situation*, extra-capsular fracture may occur at any part of the neck external to the capsule; but generally at the base, corresponding very nearly with the anterior and posterior inter-trochanteric lines. (Fig. 254.) *Comminution* is almost invariably produced; and, probably, by the penetration of the upper fragment into the trochanteric fragment, so as to split it into two or more pieces. The *direction* of the fracture in the outer fragments is also remarkably uniform; the great trochanter usually being divided from near the centre of its summit, obliquely downwards and forwards towards its base, and the line of fracture terminating a little short of the small trochanter or penetrating beneath its base; one or two lines also usually traverse the great trochanter, horizontally. In more than twenty specimens, observes Hamilton, there were only two or three exceptions to these general rules.

Fig. 254.*

Impacted fracture is produced, when the fragment is driven into, and partly imbedded in, the trochanteric fragment; the compact

* St. Bartholomew's Hospital Museum, 3, 76.

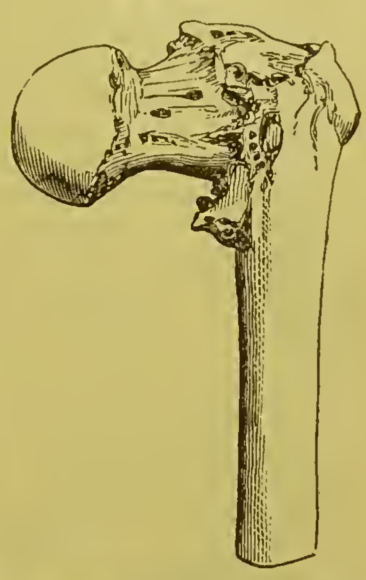
portion of which embraces, and fixes, the neck of the femur, thus shortened and slid down nearly to a right-angle. (See Fig. 254.)

The *Signs* of extra-capsular are the same as those of intra-capsular fracture, but *more marked.* Thus, shortening, averaging one inch and a quarter—in 42 cases—may reach to two, three, and even four inches. Eversion is very conspicuous, but inversion not uncommon as compared with intra-capsular fracture. Flattening of the hip is also well marked, unless swelling, which is often considerable, has supervened. Crepitus and mobility are equally notable; and these three hip-signs are even more pronounced with *comminuted* fracture. Pain, always severe, and total inability to move the joint, will no less attract the notice of the Surgeon.

Impacted fracture renders all these signs obscure or imperceptible, except shortening, which varies from half an inch to an inch. The limb cannot be extended to its original length.

Causes.—Direct violence, as by a fall on the hip, is the usual mode of fracture; occasionally, *indirect* force, as by a fall upon the feet or knees. Age has less *predisposing* influence than with relation to intra-capsular fracture. Extra-capsular fracture is said to be most frequent between the ages of thirty and forty; but Hamilton regards the liability as proportionate to advancing life, and that age may be considered as the "grand predisposing cause." Both sexes seem equally liable. The age of the patient, and the generally direct and severe violence associated with the production of extra-capsular fracture, will aid in distinguishing it from the intra-capsular.

Fig. 255.*



Union by *bone* takes place readily, and especially with an impacted fracture. (Fig. 255.) The callus is deposited, almost invariably, along the inter-trochanteric lines; and also, not unfrequently, along the lines of the other fractures of the trochanter. This callus is abundant and irregular, projecting as spines and tuberosities; forming a knobby and spiculated crown, which embraces the upper fragment. Osseous buttresses sometimes reach even to the bones of the pelvis. The use of the limb may be restored in six or eight weeks; but lameness still continues, and with impacted fracture, the limb being shortened, this condition is permanent. Sometimes the union of extra-capsular fracture is attended with depression of the neck (see Fig. 255), resulting in a proportionate shortening of the limb.

Comparing fractures of the neck of the femur, within and without the capsule, it will be seen that they differ in their structural conditions, in the degree of their signs, in their causes, and prognosis.

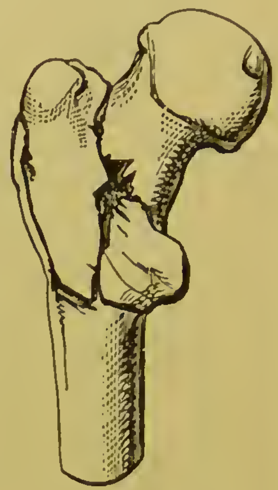
Treatment.—Moderate extension and rest, by means of the long straight splint, is here the most appropriate mode of treatment. A bandage or padded belt may be applied around the pelvis, underneath the splint, to retain the trochanter, often comminuted, in position. The

* St. Bartholomew's Hospital Museum, C. 96.

only objection I have ever experienced in the use of this retentive apparatus, has been, not as to its thorough efficiency, but the pain occasioned by pressure over the trochanter, owing to the contused state of the integuments in most cases. This inconvenience, however, is temporary, and can be overcome by using an *interrupted* splint.

Fig. 256.*

Fig. 257.*



Impacted fracture should be treated in the same way; although the splint must be applied only for retention, as the limb cannot be extended to its original length.

Fracture *partly* within, and *partly without*, the capsule, forms a structural condition which presents a combination of the signs relating to fracture of the neck of the femur, in both situations. But such cases partake more of the character of intra-capsular fracture; although, to be on the safe side in regard to treatment, retention of the limb in position, by means of the long splint, should always be the rule of practice.

Fractures relating to the *Trochanters* are extra-capsular; but there are *four* forms of such fractures, specimens of which I have met with.

(3.) *Extra-capsular fracture of the neck of the Femur*, impacted; with fracture of *both trochanters*, which are split off by the neck of the bone being driven into the cancellous tissue. (Fig. 256, front view; Fig. 257, back view. The peculiar lines of fracture here indicated are omitted from the diagrammatic view of Fractures of the Femur, p. 646.) There was slight eversion and shortening of the limb. Death occurred from pneumonia in about two months. No union of the fragments had taken place. This uncommon form of fracture was produced by a fall on the hip, in the person of a man aged 81.

Fig. 258.†

(4.) *Fracture through the great trochanter.* — The *direction* of fracture through the great trochanter is a line passing obliquely upwards and outwards from the lower portion of the neck, like an ordinary extra-capsular fracture, but instead of traversing the neck completely, it passes through the base of the great trochanter, thus separating the femur into two fragments: an upper, consisting of the head, neck, and

* St. George's Hospital Mus., 1. 182b.

† St. Bartholomew's Hospital Mus., C. 131. Bony union, seven months after injury, in a man aged 85 years.

great trochanter; and a lower, the shaft of the femur. (Fig. 258.) This fracture is very rare, and it had been verified by dissection in only two cases; the one related by Sir Astley Cooper, the other by Mr. Stanley, but the specimen represented in the figure is an additional instance.

(5.) *Inter-trochanteric fracture*, or between the trochanters, the line of fracture passing obliquely, from just above the small trochanter downwards and outwards, to below the great trochanter. (Fig. 259.) Bony union.

The signs, causes, prognosis, and treatment of these trochanteric fractures are the same as in extra-capsular fracture of the neck.

(6.) *Fracture through summit of great trochanter.*—I have found only one apparent specimen of this form of fracture, or perhaps separation of the epiphysis, as having occurred in a boy, aged fourteen, from direct violence—a fall on the hip. (See Diagram, p. 646.) Dr. Roddick, of Montreal, Canada, has, I believe, met with another instance of this form of trochanteric fracture.

FIG. 260.†

Compound Fracture of the neck of the Femur is a very formidable injury, resulting almost exclusively from gunshot wound.

FIG. 259.*

The *Treatment* is that for compound fracture, in general; hence, according to the condition of injury, retentive appliances may be used, excision of the splintered portion, or amputation of the hip, resorted to. But experience has shown that any attempt to preserve the limb entire will be almost hopeless, and amputation utterly hopeless; excision, therefore, remains as the only justifiable resource, followed by retention of the limb in the best position for union.

FRACTURE OF THE SHAFT OF THE FEMUR.—*Structural Conditions.*—The *situation* of fracture is, commonly, in the middle third of the shaft, and its *direction* oblique downwards and inwards or outwards (Fig. 260); or downwards and forwards in the lower third; and varying in the upper third; transverse in children; or the bone may be not unfrequently comminuted. *Displacement* of the lower fragment occurs, upwards and inwards, somewhat behind the upper fragment, and with some rotation outwards, as in the figure. This displacement is produced by the adductor muscles. The upper fragment is drawn or tilted forwards by the conjoined psoas and iliacus muscles, inserted into the small trochanter; and outwards by the external rotators.

* St. George's Hospital Mus., 1, 145.
† St. Bartholomew's Hospital Mus., C. 5.

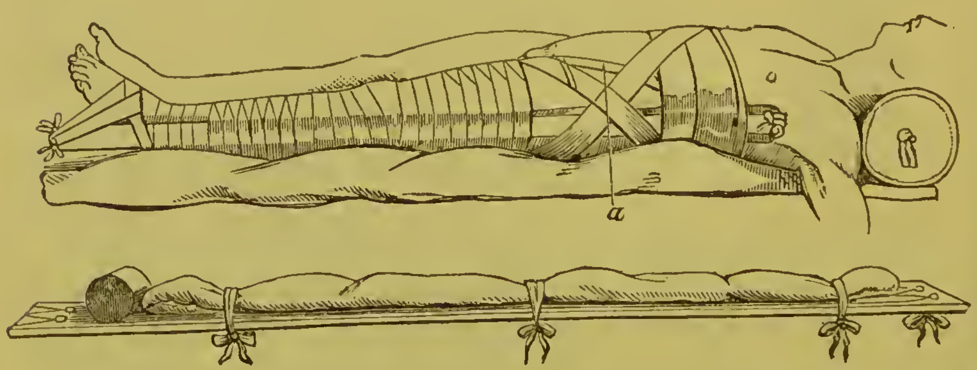
This relative position of the fragments, in the middle third of the bone, existed in a case which I examined within a few hours after the accident; it having then proved fatal. The preparation is in the Museum of the Royal Free Hospital.

The *Signs* of oblique fracture in the shaft are—deformity of the thigh, corresponding to the displacement, and occasioning a muscular fulness on the inner, and less so on the outer, aspect of the thigh; mobility, and crepitus, on extending and rotating the limb; shortening, to about one inch, but increasing with muscular action, and some eversion; pain, and inability to use the limb. *Transverse* fracture, in children, is accompanied with *angular* deformity; the ends of the fragments being incompletely displaced, and hitching on each other. The other signs are the same, differing only in degree from those of oblique fracture in the adult. These signs are usually so well marked, and especially those connected with the seat of fracture, that the nature of the injury can hardly be overlooked, and may be suspected at a glance. It is thus also that fracture in the *shaft* of any bone is always more readily detected than at either articular end, and where the diagnosis of the two or three fractures there liable to occur is even more difficult.

Causes.—Direct violence undoubtedly may be regarded as almost the only mode of fracture in any portion of the shaft; unless it be immediately above the condyles or immediately below the small trochanter. Thus, the passage of a carriage or cart across the thigh, or the fall of a piece of timber directly on it, represent the occasions of fracture. *Indirect* violence, as a fall on the feet or an indirect blow, may, indeed, fracture the shaft; but, more commonly, the bone just above the condyles, or just below the small trochanter.

Union by *bone* takes place, usually, in the course of about six weeks

FIG. 261.



or two months; but rarely, if ever, without some overlapping of the fragments and proportionate shortening of the limb.

Treatment.—Many plans of treatment have been devised, and very many forms of retentive apparatus contrived, for the treatment of Fractures of the Femur.

(1.) The *long, straight splint* will be found most effectual in *all* fractures of this bone; excepting, probably, fracture near the small trochanter above, or near the condyles below; in the former of which, the upper fragment is much tilted forwards and outwards by the

conjoined psoas and iliacus and by the external rotator muscles; and in the latter, the lower fragment is much drawn backwards by the gastrocnemius. As a means of *extension*, the long splint must exceed the length of the limb, by five or six inches beyond the sole of the foot; while, for steady *retention*, the splint should reach from near the axilla along the side of the chest and limb, to that point. These requisities are best combined in Liston's long splint; which, with a perineal band, for counter-extension, should be applied in the following manner. (Fig. 261.) The split ends of a roller are tied to the upper end of the splint, through two holes, and well secured; the roller is then drawn down on the inner aspect of the splint, and overlaid by a pad the breadth and length of the splint, to the foot, the pad being kept in position by a few tapes, binding it, at intervals, to the splint. Having well adjusted this padded splint from the axilla to the foot, the roller, running between, should be drawn round the foot, across the instep, and round the end of the splint, where it is received into deep notches, with an intervening point to catch the roller; then drawn round the foot again, and so on in a figure-of-8 fashion. The foot having been thus bound to the end of the splint, as the point of extension, the roller is continued up the limb to below the seat of fracture in the thigh; a perineal band, consisting of a handkerchief covered with oil-silk, should now be passed from the inner side of the thigh around the buttock, drawn well up into the crutch, and the ends passed through the two holes at the top of the splint. By tightening this band, the limb can be extended from below the fracture, and its adjustment having thus been completed, as shown by the length of the limb, when compared with the other, the ends of the perineal band are then tied at the top of the splint. The roller is continued up the thigh, and around the chest and splint nearly to the axilla; further securing both fragments in position, through the medium of the unyielding splint.

In *compound* fracture of the shaft, a long interrupted splint may be used; the bracketed portion opposite the seat of fracture allowing free access to the wound.

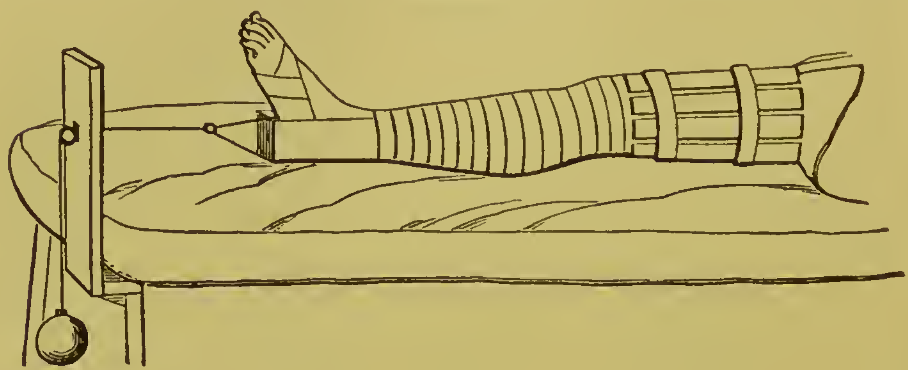
The only difficulty likely to arise in the course of treatment by the long splint, is some excoriation occasionally, from the perineal band. A little temporary relaxation of the band, or powdering the surface with flour or chalk, will usually succeed in overcoming this difficulty. In the management of a very large number of cases of fracture of the thigh, by means of the long splint and perineal band, I have never experienced any other difficulty, nor has that ever proved insuperable; while the perfect efficiency of this plan of treatment has been attested by the most satisfactory results, in regard to the length of the limb; that generally some slight shortening remains—to about half an inch, with a compensatory obliquity of the pelvis, which renders even this difference of no functional consequence in the use of the limb. In children, owing to their tender skin and restless disposition, the management of the fracture is often more difficult, and the results of treatment are somewhat less satisfactory.

It is now generally admitted by Surgeons, both in this country, in America, and on the continent, that some amount of shortening of the limb nearly always results in fracture of the shaft of the femur, whether treated by the long splint, or any other form of apparatus.

The measurement should always be taken with a graduated, inelastic tape. In seventy-four cases of fracture, at all ages, from three to sixty-three years, and in both sexes, Dr. Buck, of New York, found that nineteen had united without any shortening; a proportion of about one-fourth. The average shortening in the remaining fifty-five cases was a little less than three-quarters of an inch.

Another *method* of treatment consists in using the long external splint simply to steady the limb; or coaptation is secured by the application of four short splints to the thigh, according to Dr. Gordon Buck's method; counter-extension is maintained by the weight of the trunk, the foot of the bed being elevated on blocks to the height of a few inches, sufficiently for this purpose, and continued extension is brought to bear by means of a weight suspended over a pulley from the leg, to which it is attached by a loop of adhesive plaster. (Fig. 262.) This double arrangement obviates the risk of excoriation from the use of the perineal band; and also the tendency to ulceration of the instep,

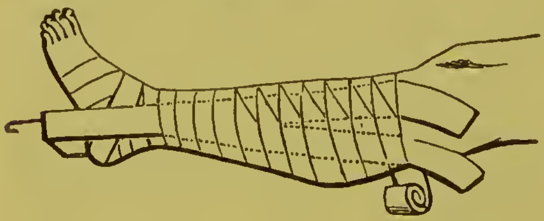
Fig. 262.



when the extending force is limited to the foot, instead of being diffused over the leg. For this latter reason, more especially, I now generally treat Fractures of the Femur by weight-extension.

This is applied by passing a long, broad strip of stout adhesive plaster down one side of the leg and up the other side, leaving a loop opposite the sole of the foot. (Fig. 263.) Within this loop, a thin plate of wood is placed, adherent to the plaster, taking care that this foot-piece be sufficiently wide—say, four inches across—to keep off any pressure from the bands over the sides of the ankle, during the continued extension. These extension-bands are further secured by the turns of a roller-bandage from the foot up the leg. Then a weight, from about ten to twenty pounds for an adult, is attached to the foot-piece of the loop by a small cord, and thus suspended over a pulley in a wooden upright frame or standard at the end of the bed. The full weight necessary for complete extension may not be tolerated well at first, and it must then be moderated for a few hours. Sometimes the aching pain of continued extension will be relieved by slightly flexing the knee, with a small pillow underneath the joint.

Fig. 263.

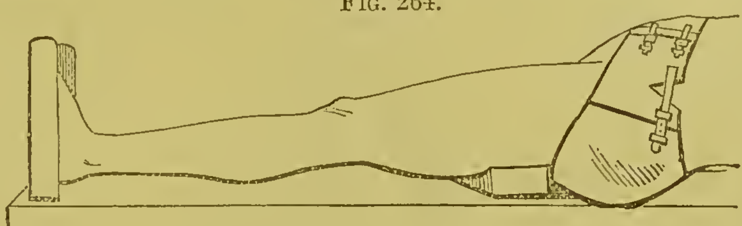


Of course, the length of the limb must be ascertained, when the fracture has thus been set, and occasionally afterwards; the extending weight being regulated accordingly.

A long *anterior* splint, with *suspension* of the limb, may be resorted to, in cases of injury to the soft parts on the back of the limb, associated with fractured femur. This splint was devised by Dr. N. R. Smith, of Maryland, and a modification by Dr. James Palmer, of the United States Navy. In the latter contrivance, the suspension is directed *obliquely* towards the foot, so as thus to more effectually maintain extension, while counter-extension is preserved by the weight of the trunk.

Fracture of the *great trochanter alone* (see Fig. 246) would not require extension of the limb, which of course is not shortened. In such case, a broad hip-bandage may be applied, and will suffice to keep the fragment in position. This method of treatment was recommended by Sir A. Cooper. (Fig. 264.) But, in most cases, there is the additional injury of fracture through the neck of the femur, or in the adjoining portion of the shaft below the trochanter. Practically, therefore, the trochanteric fracture is usually associated with the treatment of these fractures. The additional support of a hip-bandage may, however, be advantageous, whenever the trochanter can be felt distinctly movable; an uncommon condition, for this rare form of fracture is obscured by the large swelling which arises from the direct violence of the injury.

FIG. 264.



(2.) Fracture of the shaft of the femur *near the small trochanter* (see Fig. 246) may sometimes be adjusted more evenly by *relaxation of the muscles*, and the application of a splint to maintain the requisite position for that purpose; a method of treatment proposed and practised by Pott. The thigh is flexed on the abdomen, and the leg upon the thigh, and the limb laid somewhat on its outer side; an *angular splint*, moulded to the hip and thigh, must then be applied, and, perhaps, a short counter-splint on the inner aspect of the thigh. Both are secured by a bandage. Malgaigne, Hamilton, and the majority of experienced surgeons prefer the straight position, with extension, in this, as in all other fractures of the femur; that method of treatment resulting in less shortening and displacement.

In *children*, fractures of the thigh are best treated by means of two long external splints, one for either limb, with an intervening crossbar below the feet, so as to separate the legs a little. Thus the restless little patient is restrained from rolling about, and the perineum can be more readily cleansed to prevent excoriation. Hamilton particularly recommends this retentive apparatus, and I have tried it with much advantage.

Fracture *near* the *condyles*, in the *shaft*, may be conveniently associated with that of the lower articular end.

FRACTURE OF THE LOWER ARTICULAR END OF THE FEMUR.—The

direction of fracture is, generally, transverse (Fig. 265); or either condyle may be detached, thus resembling fractures of the Lower Articular End of the Humerus. These fractures also involve, or extend into, the knee-joint. (Fig. 266.) *Displacement* of the lower fragment backwards is produced by the action of the gastrocnemius muscle. Separation of the lower *epiphysis* has occasionally been met with, as verified by dissection. (Fig. 267.)

The *Signs* are, usually, clearly perceptible; some deformity corresponding to the displacement, mobility, and crepitus; pain, and loss of power in proportion to the displacement.

Impacted fracture in this situation is liable to occur. Erichsen states that he has had several such cases under his care. In one,

FIG. 265.*

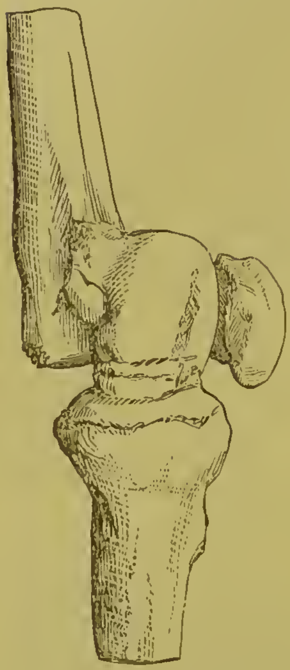


FIG. 266.†

FIG. 267.‡

the upper fragment, which was very oblique, was firmly driven into the cancellous structure of the lower one. In another case, the condyles of both thigh-bones were splintered or comminuted into a number of fragments, amongst which the shafts were impacted.

Causes.—Indirect violence, as by a fall on the feet, may detach the epiphysis, transversely from the shaft, in childhood or youth. *Direct* violence, as by a fall on the knee, or kick of a horse, may fracture either condyle.

* St. Bartholomew's Hosp. Mus., C. 58. Supra-condyloid fracture of the femur; osseous union, with great displacement of the upper end downwards into the popliteal space; also anchylosis of the patella to the femur, and of the knee-joint.

† Ibid. C. 13. Supra-condyloid fracture, comminuted, and involving the knee-joint.

‡ St. George's Hosp. Mus., 1, 137. Separation of the *epiphysis* of the lower end of the femur, with displacement of the shaft inwards. Separation also of the *epiphyses* of the tibia and fibula. This rare form of injury occurred in the person of a young man, aged eighteen, from a twist of the leg by a rope which caught

Union by bone eommonly takes plaee; and, indeed, sueh was the result in the more severe cases above noticed.

Treatment.—A *flexed position of the knee*, supported by the *double-inclined plane* or McIntyre splint, thus to relax the gastroenemius, is perhaps the most effeetual plan of treatment in these fraetures. Inflammatory swelling of the knee-joint—eoneomitant with fraeture near or into the joint—must be subdued by cold lotions or irrigation. Passive motion should be used, as soon the union will bear it, to prevent anehylosis.

The *starched* bandage will be appropriate in the treatment of *any* fraeture of the femur—as in all other Fraetures—only when retention, without any extending foree, may be suffieient. It will, therefore, be found very useful, after eonsolidation has taken plaee, to thus finish off the union, without further eonfinement to bed. Or, it may be employed from the eommeneement, in ehildren and infants; where the ordinary apparatus eannot well be applied or eontinued. In adults as well as ehildren, for the treatment of fraetures of the thigh, Mr. Eriehsen extols the starehed bandage, as being suitable, in most eases, from the eommeneement. He has thus treated "many fraetured thighs, both in adults and ehildren, without eonfinement to bed for more than three or four days, and without the slightest shortening or deformity being left." I must eonfess to never having been so fortunate in a single instance. In the last ease where I removed the long splint, and put up the limb in a starehed bandage, earlier than usual, *i.e.*, before eonsolidation of the eallus, the upper fragment progressively overlapped, oceasioning aeute pain, and the man had to go to bed again for another month.

the limb, in the act of leaping from the Chelsea pier on to a steamer. The knee-joint presented the appearance of a partial disloeation inwards of the eondyloid portion of the femur, with laeeration of the lateral and crucial ligaments. The patella remained in its natural position, although the ligaments were relaxed. There was also a eompound fraeture of the leg at its lower third, and extensive laeeration of the integument in the inguinal region. The limb, from the knee downwards, was quite eold, with eonsiderable swelling, espeeially about the knee, the ankle, and foot. Amputation of the thigh was performed immediately.

Examination of the limb disclosed the following additional partieulars:—The displacement of the shaft of the femur inwards was sueh that its external portion rested on the internal eondyle, and projected forwards. The periosteum was stripped from the lower third of the shaft, but adherent to the upper margin of the detaehed epiphysis, and formed a thiek fold posteriorly, which prevented the reduetion of the portions of bone. The epiphyseal cartilage had separated with the eondyles, thus exposing the eaneellous tissue of the end of the shaft. In the knee-joint, the ligaments were entire, exeept a slight rupture at the inner part of the posterior ligament. Within the joint, there was a large quantity of reeently effused blood. Both the epiphyses of the tibia, upper and lower, were detaehed, partially at least, earrying with them the epiphyseal eartilages; but no displaeement had taken plaee. In like manner, both the epiphyses of the fibula were detaehed. The fracture of the tibia was at the lower third of the bone; that of the fibula at the middle of its shaft. Within the ankle-joint also, some blood had been effused. The museles were extensively laeerated, and the cellular texture of the limb was infiltrated with blood. The popliteal artery had undergone a raro form of *partial* rupture—both the inner and middle eoats being torn through, for about one third of an ineh, just above tho bifureation of this vessel; and thrombosis having taken plaeo so as to obliterate the vessel for an ineh above and below that point, gave rise to the symptoms of gangrene. No injury had oeeurred to the popliteal vein, or the nerves. Pyæmia followed tho operation, and the patient died thirteen days after the aeeident. In eonneetion with this mode of death, the femoral vein was found in a state of phlebitis or thrombosis, as high as the external iliae vein; the vessel eontaining a large elot of semi-puriform blood. Seeondary abseesses had taken plaee in both lungs.

Compound Fracture of the Femur—often comminuted—results, usually, from direct violence, as severe contusion or gunshot injury.

Treatment.—The rules of treatment for Compound Fracture in general are here applicable; whether with regard to preservation of the limb intact, excision of splintered portions of bone, or amputation. The amount of injury to the soft parts—integument, cellular textures, muscles, vessels, and nerves—as well as the fracture itself, mainly determines these questions of treatment.

With the view of giving the limb its chance, the fracture having been reduced, a long splint should be applied, as for simple fracture; the splint, however, being "interrupted" opposite the injury, to facilitate the application of dressings. *Excision* might possibly be the means of saving the limb, short of the comminuted or splintered portions of bone removed. But I have not met with a case as regards compound fracture of the *femur;* though I have succeeded in thus preserving the leg in compound fracture of both the tibia and fibula. *Amputation* may prove successful in the middle third of the thigh, but never at the hip-joint. If, therefore, the fracture be so high as to render it doubtful whether amputation in the former situation should be performed, or an attempt made to save the limb, the Surgeon must use his own judgment in steering between Scylla and Charybdis. In a recent case of this kind, I was compelled to have recourse to amputation at the hip, owing to the shattered state of the limb, and the persisting dribbling hæmorrhage in spite of tourniquet compression. The patient, as usual, died in a few hours.

Compound fracture, involving the *knee-joint*, necessitates excision; or amputation, primarily or secondarily, when excision has failed.

Fracture of the Patella.—*Structural Conditions.*—In fracture of the patella, the line of fracture is generally transverse, and across the middle (Fig. 268), or sometimes the upper rim only of the bone. Longitudinal fracture may occur; or comminution more frequently, the bone being starred and broken into three tolerably equal pieces. More or less laceration and opening of the synovial capsule has been known to accompany simple fracture, as shown by a specimen in the Museum of the Royal Free Hospital. The upper fragment is drawn upwards, by contraction of the quadriceps extensor muscle; the lower fragment, fixed by the ligamentum patellæ, remaining stationary.

Fig. 268.*

The *Signs* of fracture are sufficiently obvious: a depression or interval, into which the finger readily sinks, between the two fragments, and more perceptibly when the joint is flexed; mobility of the fragments, and probably some crepitus, when the limb is extended. Pain may be inconsiderable, but marked inability to raise the limb, in addition to the above signs, can never be overlooked. (Fig. 269.) Fracture of just the upper *rim*, without any rupture of the aponeurotic capsule of the joint, will probably render these signs obscure. In one such case, and since, a second case, the patella seemed to me of the usual shape and size; no interval could be detected, the small crest-piece of bone not being drawn upwards, but slipping down into

* Roy. Coll. Surg. Mus., 543. Transverse fracture of patella. Incomplete *osseous* union.

the concavity between the condyles of the femur, and even behind the patella, itself apparently entire; and thus the fragment could not be readily moved laterally, nor brought into contact with the rest of the bone. But there was the usual powerlessness, or nearly so, in the patient's endeavour to lift his leg.

Causes.—*Muscular action* is the most frequent cause, producing transverse fracture. A person falls backwards, the knee is bent, and the patella snaps—as the tendon of the quadriceps extensor might be ruptured—by the sudden strain thrown on that muscle in the effort to regain the upright posture. But the fall is completed because the patella gives way, and the bone is not broken by falling on it. This accident happens more commonly in men, and in adult life than childhood. In like manner, after fracture of one patella, the other is more liable to be broken by muscular action; increased strain being thrown on the quadriceps muscle of the other leg, in any similar effort of self-preservation. Both patellæ have been known to snap simultaneously. *Direct violence*, as by a fall on the knee, is the occasion of longitudinal, and, more especially, of comminuted fracture. According to Hamilton, such force will generally produce transverse fracture; but muscular action invariably having this effect, the greater proportion of, if not all, transverse fractures are thus produced. Considerable swelling speedily ensues from effusion into and around the joint, in connection with fractured patella, whether produced by muscular action or by direct violence; and this is associated, in the latter case, with marked discolouration. The signs of fracture are thus more or less obscured.

Fig. 269.*

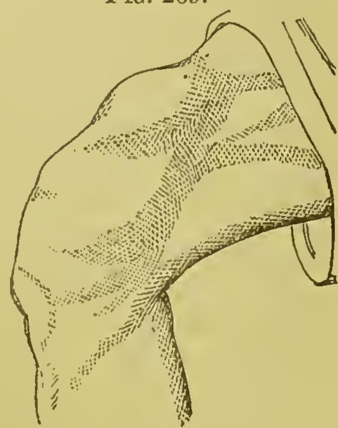


Fig. 270.†

The mode of *union* in fracture of the patella would appear to be of two kinds, ligamentous and osseous; the difference depending probably on the less or more complete contact of the fragments, during the process of union. Hence the probability as to the one or the other taking place will vary according to the direction of the line or lines of fracture, whereby the fragments are subjected to displacement by muscular action—that of the quadriceps extensor, or perhaps by an

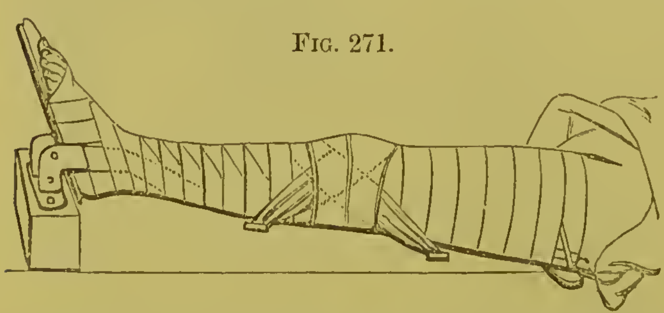
* After Fergusson.

† St. Bartholomew's Hosp. Mus., 3, 28. Two patellæ from the same person. Transverse fracture in both, separation to the extent of five inches, and connection only by a thin fibrous membrane. Enlargement of all the fragments.

altered position of the limb. *Ligamentous* union usually takes place in transverse fracture; with rare exceptions, where osseous union may occur, nearly complete contact having been maintained. Union by ligament will form even when separation of the fragments extends to an inch and a half; beyond this distance, thickened aponeurotic fascia serves as the only bond of connection. Thus the fragments may remain severed to an extent of four or five inches, and often become enlarged. (Fig. 270.) *Osseous* union, apparently, takes place more frequently in longitudinal and in comminuted fractures of the patella, the fragments remaining in apposition. Hamilton has recorded two such cases: one of longitudinal fracture across one corner of the patella; and the other, a transverse fracture near the middle of the patella, with a longitudinal fracture near its inner margin, constituting a comminuted fracture. Sir A. Cooper also succeeded in obtaining bony union in some longitudinal fractures. The proof of this mode of union having occurred in these cases, and in my own experience, has rested on two facts: permanent apposition of the fragments, without any increased separation taking place eventually, as after ligamentous union; and the absence of any mobility between them. Specimens of bony union, in fracture of the patella, would be more conclusive evidence; and this is supplied by a specimen of such union after *transverse* fracture, marked E. A. (594), in the Museum of the Royal College of Surgeons, Dublin. Incomplete ossific union had taken place in the preparation figured p. 660. Necrosis of the patella may ensue, after transverse fracture with ligamentous union; owing apparently to deficient vascular supply to the fragment affected.

Treatment.—Position of the limb, so as, by relaxation of the quadriceps extensor muscle, to bring the fragments into close apposition, is the guiding rule of treatment. The limb should be extended, and flexed on the abdomen, until the fragments would naturally fall into apposition, and this position maintained by a sufficiently elevated inclined plane on which the limb rests, and which is provided with a foot-piece. Any swelling or distension of the synovial capsule—any synovitis, consequent on the injury, having subsided, aided by an evaporating lotion, the fragments can then be brought into absolute contact. When, therefore, the swelling has diminished in the course of three or four days, during which period no reparation could have commenced, the fragments may be readily, and painlessly, retained in position by the application of a bandage immediately above and below them, encircling the limb and splint in a slightly figure-of-8 form, and tied together at the sides. This splint may be furnished with a hook above and below the popliteal space, to catch the turns of the bandage, and thus bring further pressure to bear upon the fragments. (Fig. 271.) Sometimes the additional security of a compress, or a semilunar cap of gutta-percha, just above the upper fragment may be necessary, with a counter-cap below the lower frag-

Fig. 271.

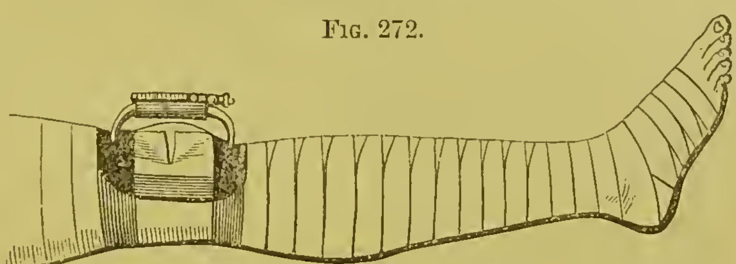


ment, just to steady it in position. The bandage should be tightened daily as the swelling subsides. Broad strips of plaster, overlapping each other, might be used instead of the bandage, but this retentive appliance cannot be tightened without reapplication and disturbance of the fragments.

Various other apparatus have been contrived, but they are all alike in principle, and none of them succeed in bringing about union better than the above described.

Malgaigne's *hooks* are a contrivance whereby the fragments can be forcibly drawn together, and retained, by steel claws thrust into them, or just above and below them. If there be no risk of penetrating the joint with this instrument, violent synovitis is not unfrequently induced. I have never thus used the clamp in my own practice; but in one case particularly, having been asked by a surgeon to see a fractured patella which was subjected to its grasp, I found a huge globular knee, pierced by the claws of the instrument, and surrounded by a gutter of pus. Nor is this instrument necessary, if the position of relaxation be duly observed. Malgaigne, I learn from Mr. W. Adams, has used the hooks in only 14 cases out of a large number of fractured patellæ; exceptional cases attended with unusually wide separation of the fragments. The hooks will be found very serviceable, and safe, for fixing the semilunar caps of gutta-percha, instead of being thrust into the bone; my own method of employing this instrument. (Fig. 272.)

Fig. 272.



Comparing the two retentive appliances, it may be fairly said that the bandage in a moderately figure-of-8 form is at least equally efficacious, and invariably safe; whereas the hooks are unnecessary, and not unfrequently perilous.

With the simple, efficacious, and safe plan of treatment I have described, *union* will be so far secure in a month or six weeks as to allow the patient to move about, guarded by a back splint and starched bandage. It is not advisable to have recourse to this substitute apparatus at an earlier period; simply because the yielding ligamentous union should not be strained by any muscular action in using the limb, or the chance of osseous union be frustrated. Even after some six weeks have elapsed, the ligamentous band continues to yield; and in the course of as many months may present an interval between the fragments of several inches, resulting in a tottering movement of the joint forwards, whenever the patient stands or walks. For *permanent* support, I have used with advantage another simple contrivance; a laced elastic knee-cap, having a leathorn receptacle to compress the patella. In one case, a gentleman, of powerful muscular development and accustomed to a sporting life, was thus enabled to go about, without any further separation of the fragments.

This apparatus should be worn until the union has become firm and unyielding, in a period from three to six months. But in thus taking care of the fracture, the tendency to anchylosis of the joint, from inflammatory effusion, must not be overlooked. Hence, passive motion should be used judiciously, in time to prevent this result.

The *union-results* of this mode of treatment—by position and bandage-retention—have been, in my own practice at least, most satisfactory. In four cases, selected as having been authenticated by notes carefully taken by Mr. John B. Foster, formerly House Surgeon at the Royal Free Hospital, the principal points of interest and importance were the following :—(1.) The fracture in all four cases was transverse, and occurred in the left patella. (2.) Three of the fractures were caused by muscular action, the fourth by direct violence. (3.) The ages of the patients were fifty-six, forty-nine, forty, thirty-three. (4.) The periods when union was *found* to be firm, and the support of a back splint in starch used only as a precaution, were ten weeks, six weeks, eight weeks, six weeks. (5.) The extent of separation between the fragments, originally, and at the end of these periods, was as follows:—Original separation, in all the cases, two inches, slightly more or less. Union-separation : one-fourth of an inch, contact, one-fourth of an inch, one-eighth of an inch.

Compound fracture of the patella rarely occurs alone. It is almost necessarily comminuted, with great injury to the joint; and results from direct violence of severe character, as some crushing force, or gunshot wound. On the other hand, the joint may be opened, but not otherwise injured; as by an incised wound, with an axe, hatchet, or other cutting instrument; or by a lacerated or a gunshot wound.

Treatment.—Special attention has been given to compound fracture of the patella, with an analysis of 69 cases collected in an elaborate paper, by Mr. Alfred Poland (Med. Chir. Trans., 1870), from which, I think, the following indications of treatment may be safely established. In compound fracture, *uncomplicated* with fracture of the articular ends of bone forming the knee-joint, *preservation* of the joint, without or with anchylosis, should always be tried, in the first instance. The wound is to be accurately closed with sutures, and ice applied; in the event of suppuration, free incision must be made, and a drainage tube may be used. The removal of any loose fragments is always advisable; but attached fragments had better be left, to regain adhesion, perchance, or be thrown off during suppuration. Failing to save the joint in a state of useful anchylosis, *excision* should be had recourse to, secondarily, that by sacrificing the joint the limb may still be preserved. The *complication* of fracture—when the articular end of the femur or of the tibia, or of both bones, are involved—must be submitted to primary excision of the joint; but extensive crushing of the bones of the joint is the only condition which renders *amputation* justifiable; and, of course, it is the only resource, as a *secondary* operation, whenever excision has failed.

Bony union seems to be a not uncommon mode of repair in compound fracture of the patella, and especially when comminuted.

Results.—The total number of cases collected by Mr. Poland is 85; 69 being compound fractures of the patella alone, and the remaining 16, complicated with fracture of the other bones in the joint—a

distinction not observed by Dr. G. Bouchard, of Paris, who had previously written a valuable paper on this injury.

Of the 69 *uncomplicated* fractures, the results were as follow:—In 8 cases of fracture, with incised wound, the recoveries were 5 without anchylosis, 1 with complete anchylosis; and the deaths 2, no operation having been performed. In 40 cases, with lacerated wound, the recoveries were 10 without anchylosis, 5 with partial and 11 with complete anchylosis, in 1 the condition was uncertain, and 4 were submitted to secondary amputation; the deaths were 8 without any operation, and 1 after secondary amputation. In 21 cases, with gunshot wound, the recoveries were 3 without anchylosis, 3 with partial and 7 with complete anchylosis, in 4 the condition was uncertain, and 1 was submitted to secondary excision; the deaths were 1 without any operation, and 2 after primary excision, by removal of the shattered patella. Of the 16 cases of fracture, *complicated* with fracture of the other bones of the joint, the recoveries were 2 without anchylosis, 2 with partial and 2 with complete anchylosis, and 1 was submitted to primary excision, 2 to secondary excision—1 being the removal of a ball from the head of the fibula—and 1 underwent primary amputation; the deaths were 1 without any operation, 1 after primary excision, 3 after secondary excision, and 1 after secondary amputation. Thus, in the *total* number of 85 cases, the recoveries were 65: 20 without anchylosis; 10 with partial, and 21 with complete anchylosis; in 5 the condition was uncertain; after excision, primary, 1; secondary, 3; after amputation, primary, 1; secondary, 4. The deaths were 20: 12 without any operation; after excision, primary, 3; secondary, 3; after amputation, secondary, 2. The total relative *mortality* was less than 1 in 4.

Fig. 273.*

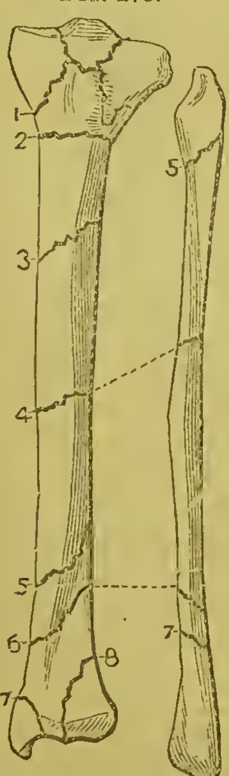


Fig. 274.†

Fractures of the Leg.—(1.) Fracture of the Tibia and Fibula, or of either Bone singly.—*Structural Conditions.*—(Fig. 273.) The *direction* of fracture is usually transverse in the upper part of these bones, especially the tibia (Fig. 274); or it may be comminuted, and extend into the

* Fractures of Tibia and Fibula.—Diagram showing situations and lines of fracture; chiefly from specimens in the Museum of St. Bartholomew's Hospital.—*Tibia.*—1. Head, comminuted into knee-joint (St. George's Mus., 1, 199). 2. Below head (Univ. Coll. Mus., 255). 3. Upper third. 4. Middle third. 5. Lower third, and below head of fibula. 6. Above ankle-joint, and the same in fibula. 7. Internal malleolus, and lower end of fibula, or Pott's fracture. 8. Lower end of tibia, into ankle-joint (St. Bart. Mus., C. 22). *Fibula.*—5, 6, 7, as in tibia. (Author.)

† Univ. Coll. Mus., 255.

knee-joint (Fig. 275); in the middle or lower part, the fracture is commonly oblique (Fig. 276), or transverse; or perhaps less frequently comminuted. These differences are dependent on the causes of fracture, above and below. *Displacement* varies with the line of fracture. Angular displacement occurs with transverse fracture, the ends of bone remaining, partly at least, in contact. This displacement is produced by the flexor muscles of the calf drawing the bones backwards, aided by the weight of the leg, and perhaps the tilting forwards of the ends of the upper fragments by the quadriceps extensor, inserted into the tubercle of the tibia. Longitudinal displacement, with the oblique fracture, is produced by the muscles of the calf drawing lower fragments backwards and upwards, as in the specimen figured. Rotatory displacement of the lower fragments may be occasioned by inversion or eversion of the foot.

FIG. 275.*

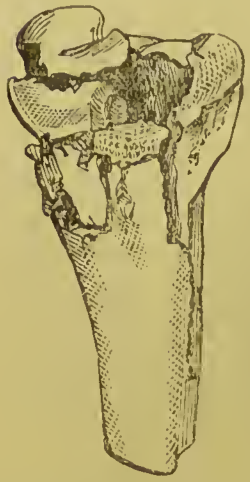


FIG. 276.†

Fracture of the tibia or fibula, *singly*, is attended with less displacement; either bone acting as a splint to the other, and especially the massive tibia in relation to the fibula.

Signs.—The signs with fracture of *both* bones are most marked. Deformity is presented corresponding with displacement; an angular projection forwards will be observed in transverse fracture, high up; a depression on the subcutaneous surface of the tibia, in oblique fracture, lower down. Mobility and crepitus are easily produced on handling the fragments; and the outline of the leg is seen to be altered, the shafts of the bones above and below the seat of fracture forming an angle; with some shortening also in oblique fracture. Pain, as in other fractures, is occasioned by any movement, and marked powerlessness of the limb cannot be overlooked; the leg can be moved about loosely as a flail below the fracture, and lies helpless in any position in which it is placed.

Fracture of the tibia or fibula, *singly*, is attended with the same signs, but less pronounced than in the case of both bones; the sound bone supporting the fractured bone. Fracture of the *tibia* presents the more obvious signs. On tracing down the bone, some irregularity will be discovered, and some mobility and crepitus of the fragments may be elicited. Fracture of the *fibula* in its upper two-thirds is obscured by

* St. George's Hospital Museum, 1, 199.—Comminuted fracture of the head of the tibia, into the knee-joint. Bony union has partially taken place between the contiguous margins of the fragments, one of which is wanting. This extensive injury was produced by direct violence, in the person of a drayman, whose knee was jammed between a lamp-post and the wheel of his cart. Death ensued from suppuration and hæmorrhage.

† St. Bartholomew's Hospital Mus., C. 110.

the peroneal muscles, which overlay the bone in this portion of its extent. By following the fibula with the finger, from below upwards, the signs of fracture may be rendered perceptible.

Causes.—*Direct* violence seems to be the only cause of fracture of these bones in their upper part. Any crushing compression, as by a wheel passing over the leg, or the jam between the buffers of railway carriages, may thus be the occasion of fracture; both bones being broken at the same height, and transversely or comminuted. Gunshot injury acts in like manner. *Indirect* violence is, probably, the more common cause of fracture lower down. A fall or leap from a height, the person alighting on his feet, breaks the tibia obliquely; and the fibula next sustaining the shock, gives way. Fracture thus seldom occurs at the same height in both bones; either bone yields at its weakest point—the tibia about the junction of its lower third, the fibula near its upper end. (See Fig. 273.)

Fig. 277.*

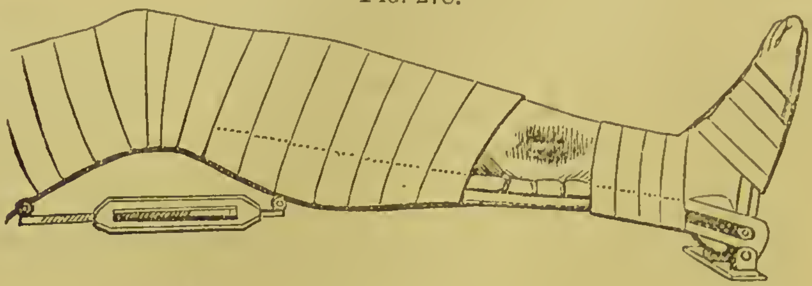
Union by bone usually takes place in about six weeks or two months; in fracture of the fibula, a shorter period, three or four weeks. Some deformity, from over-lapping and shortening, to about half an inch in extent, is apt to result, in perhaps not less than half any number of cases when carefully examined. Commonly, the upper fragment overrides the lower, and—observes Hamilton—oftener a little upon the inner than upon the outer side. The natural axis of the limb is not unfrequently changed; the lower part having fallen backwards, or inclining inwards, occasionally outwards (see Fig. 276), or forwards. In the result here represented (Fig. 277), angular displacement inwards has taken place to an extent which shows the extreme deformity that may occur from inattention in the course of treatment.

Treatment.—The fragments having been brought into apposition by moderate extension, aided by sufficient flexion of the knee, and of the thigh on the abdomen, the leg may be laid in McIntyre's double-inclined plane splint, properly padded, or that apparatus as modified by Liston. (Fig. 278.) This position of the limb overcomes displacement of the upper and lower fragments, as arising from muscular action; but displacement of the lower fragment, owing to any dropping of the leg, is still further counteracted by supporting the foot in a short sock with a tape attached to the toe, which is wound round a brass button over the end of the foot-piece of the splint. A roller is then applied around the foot and this portion of the splint to maintain extension, and continued around the leg and splint, upwards to the lower part of the thigh, or interrupted, if the fracture be compound. McIntyre's double-inclined plane may be *fixed* by screwing the end to a vertical iron support, and which is attached to a flat board, itself placed underneath the mattress of the bed on which the patient lies. A cradle is placed over the leg to raise the bed-clothes. A more comfortable arrangement, and equally efficacious, in relation to the union of fracture, is to suspend and swing the limb

* St. Bartholomew's Hospital Mus., C. 97.

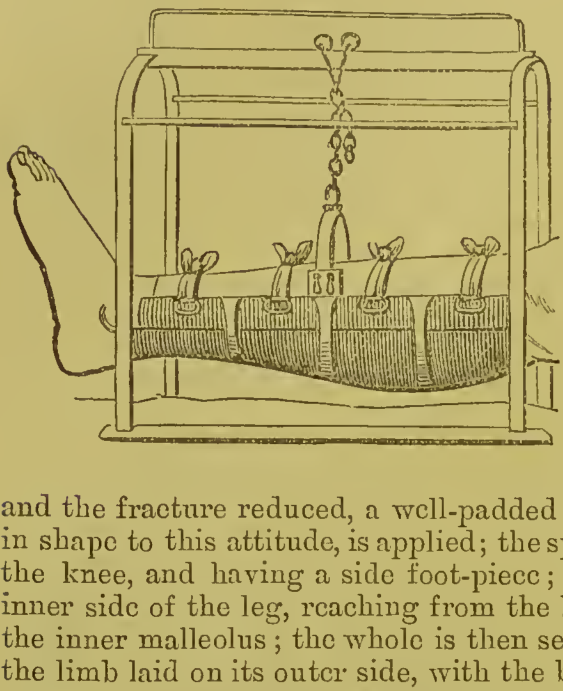
in a case of tin or wood, secured by cross straps; the limb being suspended by a chain from two pulley-wheels which run upon a horizontal

FIG. 278.



bar, supported by a light iron frame. Such is Salter's cradle-swing apparatus. (Fig. 279.) A double motion is thus allowed: a lateral swing, for ease of position to the body; and a motion in the axis of the limb, for the prevention of longitudinal displacement of the fragments, by any downward shift of position telling in that direction.

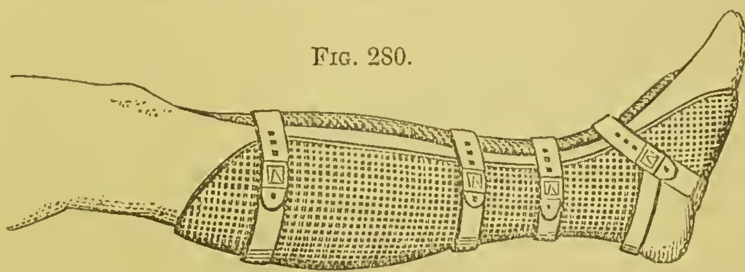
FIG. 279.



Various other apparatus have been designed for the adjustment of fractures of the leg. A fracture-box, consisting of three splints—a leg-rest with foot-piece, and two supporting side-pieces—may be used and swung in like manner. Or, the limb having been flexed, and the fracture reduced, a well-padded external splint, corresponding in shape to this attitude, is applied; the splint extending from just above the knee, and having a side foot-piece; a short splint is placed on the inner side of the leg, reaching from the bend of the knee to just above the inner malleolus; the whole is then secured by a roller-bandage, and the limb laid on its outer side, with the body also inclining to that side. This method of treatment was originated by Pott, and it is strongly advocated by Hamilton; for the alleged reasons, that displacement, with ultimate deformity, is thereby prevented—particularly as resulting from an inclination of the lower part of the leg backwards—and thus also a tendency to ulceration of the heel. But I have never experienced any difficulty or unsatisfactory result, which could be fairly attributed to McIntyre's splint, in the treatment of ordinary fractures of the leg; and the results have been, in many cases, most satisfactory,—no deformity being perceptible to the eye, nor could any irregularity be felt on passing the finger along the tibia. The wire side-splints—devised by Bauer—form a very simple and efficient apparatus, padded with cotton wadding. They can be readily adapted to the form of the leg, and thus keep the fragments well adjusted. But I would recommend the additional prolongation of both splints around the sole of the foot, forming a foot-piece. (Fig. 280.) A roller-bandage, carried up

the leg, will secure the whole in position. Fracture, very oblique, or comminuted, may occasion some difficulty as to the retention of the fragments in apposition. It is here that division of the tendo-Achillis —Laugier's proposal—seems a justifiable procedure, with the view of

FIG. 280.



correcting the displacement arising from muscular contraction. This resource certainly proved effectual in one case under my care, where the tibia was broken just above the ankle-joint, attended with marked retraction of the foot, and threatened protrusion of the upper end of the fracture. Erichsen divided the tendon, apparently with less success, in two cases.

(2.) FRACTURES OF THE LOWER ENDS OF THE TIBIA AND FIBULA, OR OF EITHER BONE SINGLY.—*Structural Conditions.*—Five forms of fracture

FIG. 281.*

FIG. 282.†

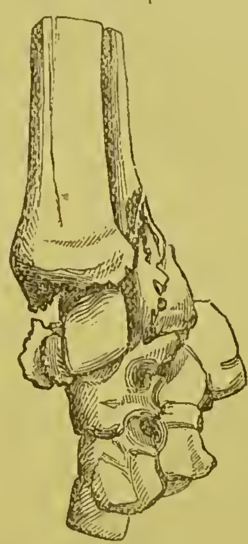


FIG. 283.‡

are liable to occur near the ankle-joint:—(1) fracture of the articular end of the tibia, obliquely from without downwards and inwards; and of the fibula about three inches above the ankle (Fig. 281); (2) fracture of the fibula about three inches above the ankle, with the tip of the internal malleolus of the tibia, this double fracture constituting *Pott's Fracture*, a very common form (Fig. 282); (3) fracture of the fibula two to three inches above the external malleolus, with rupture of the internal lateral or deltoid ligament; (4) fracture of the internal malleolus of the tibia; (5) fracture involving the ankle-joint. (Fig. 283.)

Displacement in these fractures varies: in fracture of the Tibia and Fibula, the upper fragment of the Tibia usually projects *inwards*,

* St. Bartholomew's Hospital Museum, C. 18.

† Ibid. C. 137. ‡ Ibid. C. 22.

and both fragments of the Fibula also in that direction; in fractures of the Fibula and Tibia, or of the Fibula alone, the same displacement of its fragments occurs—*i.e.*, inwards towards the tibia; in fracture of the internal malleolus of the Tibia, displacement of this fragment is still inwards.

Dislocation takes place, not unfrequently, in connection with each of these fractures, and with that in particular of the inner malleolus *alone;* which, I believe, seldom happens without, and from, dislocation of the tibia outwards. Respecting fractures of the *fibula*, Hamilton writes: "In *all* the fractures which have been produced by falls on the bottom of the foot, and in all except one produced by a slip of the foot, the accident was accompanied with a dislocation of the ankle; the foot being turned outwards." The exceptional case was doubtful.

Signs.—Deformity is presented, corresponding to the displacement of one or both fragments, with, perhaps, dislocation; and mobility with crepitus, discovered on handling the part.

Fracture of the articular end of the tibia obliquely, and of the fibula, produces a notably increased breadth of the ankle-joint, between the malleoli, with some eversion of the foot, and obliquity of its axis, the toes being turned outwards and the heel inwards.

Fracture of the lower end of the fibula, and of the internal malleolus, or Pott's fracture, is accompanied with a very notable eversion of the foot; the sole being turned somewhat upwards as well as outwards, so that the outer edge is directed upwards, and the inner side downwards, on which the patient rests. Thus, Sir A. Cooper, describing his own case, observes: "I broke my right fibula by falling on my right side, whilst my right foot was confined between two pieces of ice; and I could with difficulty support myself to a neighbouring house by bearing on the inner side of the foot."

Causes.—*Indirect* violence is certainly the more common cause of these Fractures; either by a fall or jump from a height, breaking the tibia, and fibula secondarily; or by violent eversion or inversion of the foot, breaking the fibula, with the internal malleolus, or rupturing the deltoid ligament; or snapping off the inner malleolus alone. The relative frequency of the two latter modes of indirect force has been doubted; most surgical authorities regarding violent eversion as the more frequent; but Dupuytren found inversion to be the ordinary occasion of fracture. Thus, in 200 cases of broken fibula, 120 were produced by inversion or twisting the foot inwards, and 60 only by eversion or rolling of the foot outwards; the remaining 20 arising from *direct* violence applied to the bone itself.

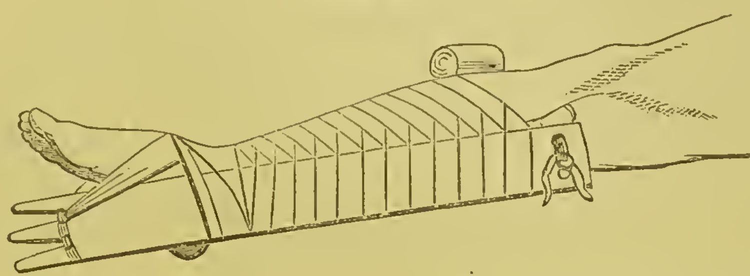
Union of fracture—not involving the ankle-joint—takes place readily; and without any appreciable displacement, under proper management and supervision.

Treatment.—In all these Fractures, McIntyre's double-inclined plane splint, or Liston's modification of that apparatus, will be found a most efficient means of retaining the fragments in position; and the more so proportionately to their mobility. The trough in which the leg rests steadies the upper fragments; the foot-piece counteracts any tendency to twisting of the foot inwards or outwards; and the sock supports the heel.

Any marked tendency to eversion of the foot, as in Pott's fracture, may be more effectually restrained by Dupuytren's splint: a short,

straight splint applied to the inner side of the leg, from the knee to the foot. (Fig. 284.) The pad should be doubled just opposite the inner malleolus, and a roller wound round the foot and splint in a figure-of-8 form, thereby drawing the foot inwards over the thick pad as a fulcrum,

FIG. 284.

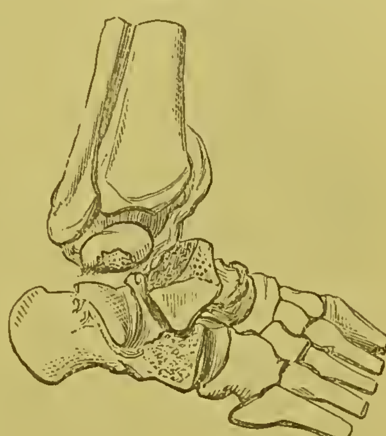


and the roller is then continued upwards to the knee to steady the splint. Some tendency to anchylosis of the ankle-joint must be met by timely recourse to passive motion, and relapsing swelling may require the support of a bandage for a considerable period.

Compound Fractures of the Leg, and of the Ankle-joint.—In the *former* situation, compound fracture of the Tibia and Fibula, or of the Tibia alone, happens more frequently than similar injury of any other bone. It was, therefore, selected as the typical form of such Injuries in describing COMPOUND FRACTURE generally. (Ch. XXXI.) Its Pathology and Treatment are there considered.

In relation to the *ankle-joint*, compound fracture presents no differences of practical importance. The same considerations guide as to the preservation of the limb, excision, and amputation.

FIG. 285.*



FRACTURES OF THE TARSAL, METATARSAL BONES, AND TOES.—These bones are liable to both Simple and Compound Fractures, and with the usual signs of such injuries.

The *Astragalus* is very seldom fractured, without fracture of other tarsal bones. The line of fracture may be transverse, or, longitudinal, or perhaps horizontal (Fig. 285), sometimes attended with comminution; and with, or without, impaction of the fragments. Usually, the injury is complicated with dislocation of the foot outwards, or inwards, and with fracture of the fibula. Generally also, the dislocation is compound.

The *signs* will be some crepitation and mobility of the fragments on flexing and extending the foot, backwards and forwards; but there

* St. George's Hospital Mus., 1, 247. Fracture of the astragalus, separating the superior third from the remainder of the bone. The lower fragment is partially dislocated. All the ligaments of the ankle-joint are torn, excepting the internal lateral, which is attached to the periosteum, as the only connection between the bones of the leg and the foot. This rare fracture was caused by direct violence, an omnibus wheel passing over the foot. Amputation, and recovery. (See also "Brit. Med. Journal" (1862), part i. p. 328.) In another case, with fracture of the astragalus, the foot, and therefore the os calcis, was dislocated backwards and inwards, with some rotation. (St. Thomas's Hosp. Mus., B. 29.)

may be no displacement—the bone being held in position betwixt the malleolar arch and the calcaneum, although sometimes the upper fragment is driven up and wedged between the ends of the tibia and fibula. As accompanied with dislocation, the additional signs of that injury will of course be presented.

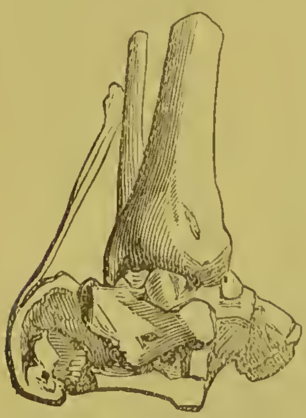
Causes.—Indirect violence seems to be the more common cause of fracture through the astragalus; in 10 cases collected by Dr. B. Monahan, 9 occurred by a fall from a height on the feet, 1 only from direct force, crushing the foot.

Treatment must be guided by the amount of injury. Thus, the reduction of displacement can sometimes be accomplished, and then maintained in a McIntyre's splint; but excision of a displaced fragment will be necessary, when it cannot be reduced and kept in position; and amputation of the foot is the only resource of treatment for a crushing injury.

Compound fracture of the astragalus, with perhaps protrusion of a displaced fragment, may be produced, partly by the displacement, but principally by the violence of the injury. This condition of fracture generally admits only of amputation.

Fracture of the os calcis presents particulars worthy of notice. The bone is broken transversely, or comminuted occasionally, with perhaps impaction; and the line of fracture may be either *behind* the lateral ligaments, or through the *body* of the bone. (Fig. 286.) In the former situation, there will be some displacement, the posterior fragment being drawn upwards by the muscles of the calf; in the latter situation, this fragment is retained in position by the lateral ligaments and the strong interosseous ligament.

Fig. 286.*



The *Signs* of this fracture vary accordingly. Marked flattening of the heel on its plantar aspect, or even a depression upwards, and projection of the fragment posteriorly, with mobility and crepitus, denote fracture behind the lateral ligaments; of which injury I have had one well-marked case. Comparative absence of these signs, and particularly of the deformity of the heel, denotes fracture more anteriorly, or that across the body of the bone.

Causes.—*Direct* violence is, probably, the only cause of fracture; as by a fall from a height, the person alighting on his heels, or by a cart-wheel passing over and crushing the foot. Very rarely, the os calcis may be broken transversely, by the powerful action of the muscles of the calf, in jumping or falling on the toes. Twelve such cases are recorded; 8 having been collected by Malgaigne, 2 by South in Chelius's Surgery, and 2 by B. Cooper in his edition of Sir A. Cooper's work.

Treatment consists, as usual, in the adjustment of the fragments, with relaxation of any opposing muscular action; and their retention in position. A gutta-percha or pasteboard splint must be contrived according to the fracture; and, when necessary to place the leg in the flexed attitude, with the heel drawn up, this position may be maintained

† St. Bartholomew's Hosp. Mus., C. 126.

by the apparatus used for rupture of the *tendo-Achillis*. Or, the tendency to displacement and the more severe contusion may require the support of a McIntyre's splint, used as a double-inclined plane. In this, and other fractures of the tarsal bones, passive motion should be employed in time to prevent anchylosis.

Compound fracture generally allows only of excision or amputation. But—as in regard to the hand—the removal of any portion of the foot should be guided by great circumspection and judgment; having due regard to the extent of the injured part, and the preservation of this valuable member.

CHAPTER XXXIII.

DISEASES OF BONE.

Inflammation of Bone.

Bone, or the *Osseous tissue*, with its investing *Periosteum*, and the *Endosteum* or *Medullary Membrane* of long bones, are, severally, subject to Inflammation. But the pathology of Inflammation as affecting each of these structures is intimately associated, and they are commonly affected simultaneously, or consequently. It will, therefore, be more natural to describe in order, first, the structural alterations pertaining to Ostitis, Periostitis, and Endostitis, and then their diagnostic characters, causes, consequences, and treatment.

(1.) Ostitis, or Inflammation of Bone.—The cellulo-fibrous network—the organic basis of the lamellæ in the compact and cancellated structure of Bone, with the vascular network ramifying in the Haversian canals and cancelli, is alone the *seat* of inflammation; the inorganic matter, superadded to the fibrous network in the process of ossification, not being subject to any perversion of nutrition or other vital change.

The blood-vessels become enlarged—as shown by Von Bibra—giving an injected red appearance to the portion of bone undergoing inflammation; and the fibrous matrix, probably, passes into a state of fatty transformation, as in inflammation of most other textures. The inorganic or earthy matter undergoes merely a disintegrative separation from the fibrous matrix with which it was intimately connected, but retains its chemical composition, and is then absorbed. Such are the earliest structural and chemical alterations in the inflammation of bone. A change of consistence—softening—accompanies this fatty liquefaction of the organic matrix and unloosening of the inorganic matter. But the Haversian canals, lacunæ, and canaliculi soon become the seat of disintegration and absorption, whereby these natural cavities are rendered more conspicuous under the microscope; or, opening into neighbouring cavities, irregular spaces are formed. The compact structure thus acquires a rarefied or porous character, presenting the appearance of cancelli; while the cancellated portion is exaggerated, as in the neighbourhood of necrosis, or death of bone, when

consequent on inflammation. (Fig. 287.) Within these spaces the fatty matter and earthy salts—detritus of the osseous tissue—accumulate; and the products also of inflammation are deposited. They consist of plastic lymph and exudation-matter, or pus; the one kind of deposit resulting in induration and hypertrophy of the bone (Fig. 288), the other in increased softening and disorganization.

Fig. 287.*

Fig. 288.†

The description of *these* changes belongs to the consequences of Ostitis.

Scrofulous ostitis structurally resembles simple inflammation of bone; the osseous substance being disintegrated and absorbed. Thence the bone is light, soft, and oily. But the rarefied cancelli or spaces in the compact texture are filled with peculiar products; a red jelly-like matter, or occasionally, a deposit of tubercle. The former is always diffused. The accompanying chemical changes—according to Dr. Black's analyses—consist in a considerable increase of fat in the diseased bone, a large diminution of the salts of lime, a diminution of the organic matrix, and an increase of the soluble salts. Associated with these destructive alterations, minute projections of bone from the walls of the cancelli evince an attempt at osseous reproduction, thus corresponding to the induration or sclerosis which results from simple inflammation of bone.

Tubercle in bone may be either diffused or circumscribed; the latter form being comparatively rare. *Diffused* tubercle occurs commonly in the shaft of long bones. It occupies the cancelli, and appears as a nodulated, or granular, yellowish mass of soft consistence; extending frequently along the whole length of the shaft. *Circumscribed* tubercle is deposited most frequently on the outside of the skull, beneath the periosteum, constituting the *strumous* node; and scarcely less frequently, in the cancelli of the articular end of a long bone, usually the tibia. Tubercle in bone sometimes becomes actually *encysted;* as well as in the lungs, in which organs I have seen cretaceous tubercle enclosed in a distinct cyst.

Tubercular deposit, in either form, is prone to undergo *softening;* the diffused, it is said, passing into this state, less frequently and rapidly than the circumscribed. This change is always one of serious consequence. The softening of tubercular deposit induces, or is attended with, inflammation of the surrounding bone, and suppuration. An *abscess* thence results, and the bone around becomes condensed and indurated. Or Caries and Necrosis ensue, destroying the osseous

* St. Bartholomew's Hosp. Mus., 1, 132. Necrosis of wall of femur. near the lesser trochanter, with rarefaction of the cancellous structure between it and the great trochanter.

† Ibid. A. 3.

texture. Thus, softened tubercle, a curdy, unhealthy pus, and carious or necrosed portions of bone are commonly found associated and intermixed. The matter extending, may sometimes find its way to the surface; and a chronic abscess, communicating with the bone, remain, discharging, or with little disposition to heal. Or, the matter may find its way to a neighbouring joint, destroying the articulation. But the comparatively limited localization of tubercle diminishes the perilous results of these destructive changes. If the shaft of a long bone be affected, the articular ends are, generally, free; and if either end of the bone be the seat of tuberculous deposit, the shaft escapes.

FIG. 289.*

Syphilitic ostitis does not seem to be distinguished from simple inflammation of bone by any structural differences of practical importance.

(2.) PERIOSTITIS.—Inflammation of the periosteum is usually connected with that of the bone itself—ostitis. The periosteal membrane becomes more vascular, thickened, softened, and loosened from its connection with the subjacent bone. These alterations may be seen, sometimes, in the bone of a stump, after amputation. Subsequently, an osseous deposit may take place between the periosteum and bone, with some enlargement and induration of that portion of bone, constituting a *node*. (Fig. 289.)

A *syphilitic* node, which may be regarded as the type, arises from an effusion of lymph between the periosteum and bone; and proceeding from the former, at length involves the bone.

A *strumous* node, on the other hand, consists of scrofulous matter between the periosteum and bone, in consequence of a carious state of that portion of bone.

Suppuration will be noticed as a consequence of Periostitis.

FIG. 290.†

(3.) ENDOSTITIS.—Inflammation of the endosteum, or membrane lining the medullary canal and cancelli, is, probably, of less frequent occurrence. This membrane, however, undergoes analogous changes to those of the periosteum, when inflamed—increased vascularity, and thickening. A deposit of lymph or pus ensues, in consequence of endostitis. (Fig. 290.) The section of a tibia, in this illustration of endostitis, shows not only that suppuration has taken place in the medullary canal and adjoining cancellous tissue, but also that the latter structure has become consolidated, in parts, by the production of new bone; thus corresponding to the result of ostitis, which has also occurred, as shown by the great thickness of the walls of the bone.

SIGNS.—*Ostitis*, affecting the deeper portion of the substance of a bone, is unattended with any appreciable signs, in the first instance. A deep-seated wearing pain generally precedes any altera-

* St. Bartholomew's Hosp. Mus., A. 23.

† Ibid. 1, 131.

tion of external appearance. This pain is more severe at night, and aggravated by changes of weather; thus resembling rheumatic pain, for which it may be mistaken. Enlargement of the bone at length becomes perceptible; with, perhaps, some redness, œdematous swelling, and tenderness of the integument. This swollen state of the integument renders any enlargement of the bone more apparent than real. Softening of the bone, in some portion of its substance, may eventually be detected on pressure; but the diagnosis will be sufficiently obvious, without subjecting the patient to the pain of such examination. Inflammatory fever, of varying intensity, accompanies these local symptoms.

Scrofulous ostitis is attended with more considerable enlargement of the bone, and of an indolent character. The surrounding integuments are œdematous, white, and painless; becoming somewhat red and tender, as suppuration supervenes. The concomitant symptoms of scrofula will also determine the diagnosis.

Syphilitic ostitis must be diagnosed entirely by the concurrence of present and past symptoms of Syphilis.

Periostitis.—The symptoms are similar to those of ostitis, but more simultaneous and superficial. A painful, puffy swelling is presented, the pain subject to exacerbations, and the swelling acquiring a bony hardness. These diagnostic characters are well illustrated by an ordinary syphilitic *node* in a subcutaneous bone, as the shin.

Endostitis is not characterized by any peculiar symptoms, apart from those of Ostitis.

Like the inflammation of other parts, ostitis and periostitis may be distinguished as *acute* or *chronic*, according to the more or less severe character of the symptoms, and their duration. In the latter or chronic state of osteal or periosteal inflammation, the patient, worn down by long-continued pain and sleeplessness, presents the constitutional symptoms of hectic.

Variety of *Chronic Ostitis*—"Osteitis Deformans."—Under this title, Sir James Paget has described an hypertrophy and softening of the bones, as the result apparently of chronic inflammatory change; and the chief characters of which disease are best expressed in his own abstract of the original communication to the Royal Medical and Chirurgical Society (1877):—This form of chronic ostitis "begins in middle age or later, is very slow in progress, may continue for many years without influence on the general health, and give no other trouble than those which are due to the changes of shape, size, and direction of the diseased bones. Even when the skull is hugely thickened, and all its bones exceedingly altered in structure, the mind remains unaffected.

"The disease affects most frequently the long bones of the lower extremities and the skull, and is usually symmetrical. The bones enlarge and soften, and those bearing weight yield and become unnaturally curved and misshapen, suggesting the proposed name 'osteitis deformans.' (Fig. 291.)

"The spine, whether by yielding to the weight of the overgrown skull or by change in its own structures, may sink and seem to shorten, with greatly increased dorsal and lumbar curves; the pelvis may become wide; the necks of the femora may become nearly horizontal. But the limbs, however misshapen, remain strong and fit to support the trunk.

"In its earlier periods, and sometimes through all its course, the disease is attended with pains in the affected bones, pains widely various in severity and variously described as rheumatic, gouty, or neuralgic, not especially nocturnal or periodical. It is not attended with fever. No characteristic conditions of urine or fæces have been found in it. It is not associated with any constitutional disease, unless it be cancer.

FIG. 291.*

"The bones examined after death show the consequences of an inflammation affecting, in the skull, the whole thickness, in the long bones chiefly the compact structure of their walls, and not only the walls of their shafts, but in a very characteristic manner those of their articular surfaces.

"The changes of structure produced in the earliest periods of the disease have not yet been observed; but it may be believed that they are inflammatory, for the softening is associated with enlargement, with excessive production of imperfectly developed structures, and with increased blood-supply.

"Whether inflammation, in any degree, continues to the last, or whether, after many years of progress, any reparative changes ensue, after the manner of a so-called consecutive hardening, is uncertain."

CAUSES.—Inflammation of bone usually results from *external* violence or from exposure to cold or damp; but it arises under the influence of some predisposing *constitutional* condition of disease. These predisposing causes comprise secondary or constitutional syphilis, or the excessive influence of mercury—of rare occurrence now-a-days; the scrofulous taint; rheumatism; fevers; and probably other conditions affecting nutrition. Either class of causes—the traumatic or the constitutional—may be *alone* sufficient to induce osseous inflammation. The bones most liable to inflammation are, however, those most exposed to the action of external agents. Hence, the tibia, cranium, and especially the frontal bone, the clavicle, sternum, ribs, and bones of the foot and hand, are most commonly affected.

CONSEQUENCES.—The consequences of inflammation of bone have been incidentally noticed in describing its structural conditions, and particularly in connection with scrofulous ostitis. They may now be more definitely stated as follow:—(1.) *Absorption* and *rarefaction* of the bone having taken place, the osseous texture may be found in this state, before the supervention of much deposit—representing the *osteoporosis* of Rokitansky, or a form of *atrophy* as affecting bone. (See Fig. 287.) (2.) *Induration*, or *sclerosis*, having taken place, an increasing deposition of plastic lymph and its ossification results in considerable thickening of the substance of the bone (see Fig. 288) and perhaps irregular osseous deposit on its free surfaces. (Fig. 292.) Thus, a long bone becomes thickened in the diameter or substance of its shaft, and deposition proceeding within the medullary canal, its bore is narrowed; while periosteal deposit, and perhaps osseous out-

* St. Bartholomew's Hosp. Mus., A. 183. Sections of Tibia and Patella.

growth, at the same time enlarge the circumference of the bone—as in the analogous production of external callus, occasionally, during fracture-union. Elongation of a long bone is, sometimes, consequent on its inflammation. The tibia has thus become longer than its fellow by nearly two inches. The osseous substance, resulting from inflammatory induration, is more solid, heavier, and harder than that of healthy bone, increasing even to the consistence of ivory; and the nutritious foramina are said to be increased in size. This state of *hypertrophy* corresponds to the inflammatory solidification of parenchymatous organs. But, as regards bone, it is a termination by restoration to health, or something beyond the natural condition of healthy bone. (3.) *Suppuration* of bone—another consequence of inflammation, of an opposite character to induration—merits a separate notice; also *Caries*, or ulceration of bone; and *Necrosis*, which is analogous to sloughing or mortification of the soft textures.

FIG. 292.*

TREATMENT.—In *traumatic* and *acute* inflammation of bone—whether in the form of Ostitis or Periostitis—the ordinary remedial measures for inflammation will usually suffice. Warm fomentations, leeches, and rest, with the administration of calomel and opium, are appropriate. Billroth strongly recommends iodine paint applied to the whole limb, continued until large vesicles form, and renewed when this vesication disappears. In *constitutional* and *chronic* inflammation this treatment must be supplemented, or partly superseded, by the general treatment for secondary syphilitic affections, scrofula, or rheumatism. Iodide of potassium is thus often singularly efficacious in syphilitic or rheumatic ostitis or periostitis.

Tension and insupportable pain are more readily and permanently relieved by free incisions, than by any medicinal treatment. In periosteal tension, these incisions should be made down to the bone; in tension resulting from ostitis, an incision may be prolonged, by means of a Hey's saw, through the bone, down to the medullary canal. Trephining the bone has been resorted to for the relief of osseous tension. Chronic thickening, unattended with much pain, may be removed or lessened by the application of blisters, iodine and mercurial ointments.

SUPPURATION OF BONE.—Suppuration, in connection with bone, is liable to take place in either of the three situations described with reference to inflammation, and it may be either diffused or circumscribed; these conditions being also, less definitely, acute or chronic suppuration, respectively. Thus we recognize—(1) Osteo-myelitis, *diffuse* suppuration of bone, within the *medullary canal* and cancelli; (2) *Diffuse Periostitis*, and *Periosteal Abscess;* and (3) Circumscribed *abscess* of *Bone*, within either the cancellated or compact structure.

(1.) *Osteo-myelitis.*—This condition certainly occurs, and not unfrequently; but—as Mr. Holmes observes—it is less frequently recognized at the bedside than in post-mortem examinations. The results are disintegration of the cancellated structure (Fig. 293), and diffuse

* St. Bartholomew's Hosp. Mus., 1, 375.

suppuration, the canealli being found loaded with pus, while the medullary membrane is usually injected and often sprinkled with ecchymoses; the periosteum is often partly separated from the bone, but the compact osseous texture has not generally undergone any appreciable change. (Fig. 294.) In the typical specimen here represented, the section of a tibia, from a boy eighteen years of age, exhibits the effects of acute inflammation both in its medullary canal and in the periosteum. Lymph and pus are abundantly deposited in the cancellous tissue throughout its whole extent. Irregular ulcerations have extended through either end of the bone, and articular cartilage into the knee and ankle-joints; suppuration has also taken place between the epiphyses and the shaft of the bone. The periosteum, separated from the shaft in nearly its whole length, is very vascular, thick, pulpy, and velvety on its inner surface. At this stage, in the larger bones, the disease usually terminates fatally. Otherwise, the pus may penetrate into adjoining parts, probably into the nearest joint, as in the case described; or central necrosis may ensue. In young persons, suppuration is apt to extend to the epiphysis, as in the knee-joint; affecting the end of the femur, or the head of the tibia, as one or other bone is the seat of myelitis. The epiphysis becomes detached from the shaft. Sometimes both epiphyses, upper and lower, are involved, Billroth having seen a double separation occur once in the tibia.

Fig. 293.*

Fig. 294.†

The *Signs*—during life—are neither absolute nor obvious. Separation of the periosteum, with diffused pain in the bone, and diffuse inflammation of the integuments, are equally the symptoms of osteo-myelitis and of diffuse periostitis. An absence of effusion between the periosteum and bone is distinctive of osteo-myelitis; but this condition can scarcely be determined by external examination of the bone, and is often rendered more obscure by the superimposed œdematous swelling. With detachment of the epiphysis, there is mobility of the part, as in fracture; and dislocation may be produced by muscular action.

The *cause* is usually some injury implicating the medullary membrane and cancellated structure of the bone affected. Thus, osteo-myelitis not unfrequently follows compound and comminuted fractures, gunshot wounds, amputations, and other operations exposing the medullary canal.

It runs a rapid course, is commonly succeeded by pyæmic infection, and thence terminates fatally.

Treatment.—*Preventive* measures afford the only reasonable chance of anticipating this issue; the cure of pyæmia being beyond the reach

* St. Bartholomew's Hosp. Mus., 1, 4. Drawing. † Ibid. 1, 195.

of any known remedial agents. The ambiguous symptoms of diffused pain in a bone, with perhaps some œdematous swelling, will therefore warrant the Surgeon in ascertaining the state of the periosteum, to determine the diagnosis. Under these circumstances, an early, free incision should be made down to the bone.

If the periosteum is discovered to be separating, without any notable effusion between it and the bone, it will be justifiable to *trephine* the bone, with the view of giving exit to any matter which may have formed in the deeper cancellated structure. *Excision* of the affected portion of bone, or *amputation* of the limb, must be had recourse to, as more extreme measures.

(2.) *Diffuse Periostitis.*—This diseased condition is of rather frequent occurrence; but it has hitherto been less noticed in surgical works than its importance demands. Diffuse Periostitis—according to Mr. Holmes' observations—appears to consist in the partial separation of the periosteum from the bone; by effusion of lymph or other products on the surface of the latter. Copious suppuration soon spreads along the bone, detaching the periosteum, often from one end of the bone to the other. (Fig. 295.) At an early period, neither the periosteum nor the surface of the bone is visibly inflamed. The latter, indeed, may look white and bloodless, or sometimes slightly worm-eaten; it yields, on pressure, large drops of blood from the periosteal vessels passing into it, and its superficial layers are more readily separable from the deeper osseous texture, than in health. Necrosis is soon established, the whole diaphysis of the bone usually perishing; leaving the articular ends unaffected, and therefore not involving the neighbouring joint. Sometimes it does not escape. The long bones are more often affected than the flat or irregular bones; and, in the great majority of cases, the femur or the tibia.

Fig. 295.*

Signs.—Arising insidiously, an œdematous, painful swelling is presented—diffuse cellular inflammation—resembling acute rheumatism. But, suppuration soon following, the diagnosis is at once determined.

The *causes* would seem to be some injury to the bone, occurring, however, in a scrofulous or weakly person. The disease is said to be met with more commonly about the age of puberty, and in boys more often than in girls.

It rapidly runs its course; pyæmia frequently supervenes and proves fatal; or the matter burrowing among the muscles, forms numerous fistulous openings, exposing necrosed bone. The dead portion is detached much sooner, apparently, than in ordinary necrosis; and reparation also seems to be equally active.

Treatment.—Early and free incisions are here, also, primarily important. During the process of cicatrization, injections of very dilute hydrochloric acid may be used, as highly recommended by Chassaignac, to cleanse the suppurating cavity and hasten exfoliation

* St. George's Hosp. Mus. Diffuse periostitis of the Tibia, with necrosis and detachment of the lower epiphysis.

of the dead bone. A generally stimulating and tonic plan of treatment will be required to support life through this trying ordeal.

Chronic periosteal abscess remaining, requires no special treatment.

(3.) *Circumscribed Abscess of Bone.*—Always a *chronic* condition, this state of suppuration differs also from diffused suppuration, in its limited extent, and in being distinctly circumscribed. The abscess, thus defined, is seated within the substance of a bone, usually its cancellated structure; the cavity may be lined by a distinct pyogenic membrane—of which there is a rare specimen in the Museum of St. Bartholomew's Hospital—and the surrounding bone is more vascular than natural, and much indurated. The size of this cavity is never large, probably not exceeding that of a small chestnut, and containing two or three drachms of pus, greenish yellow or dark coloured. Always situated in one of the long bones, the abscess is commonly located in its upper or lower articular extremity, and very rarely within the medullary canal of the shaft. The *tibia* is most frequently affected, and its upper end near the knee-joint (Fig. 296); its lower end near the inner malleolus, next in order of frequency; and among other bones, the lower end of the humerus near the elbow, and the femur, have severally been found the seat of circumscribed abscess. Sir B. Brodie first discovered and described this abscess, and pointed out its appropriate treatment; since the time of his observations, it has occasionally been met with by other Surgeons; and recently, Mr. T. Carr Jackson contributed an instructive paper with three cases bearing on the subject. In contrast with abscess of bone, a central cavity may result from *atrophy;* the osseous texture around being rarefied, instead of having indurated by interstitial deposit, and with expansion of the bone. Such was the case in the bone of a stump, after amputation (Fig. 297); a most instructive illustration of this distinction.

Fig. 296.*

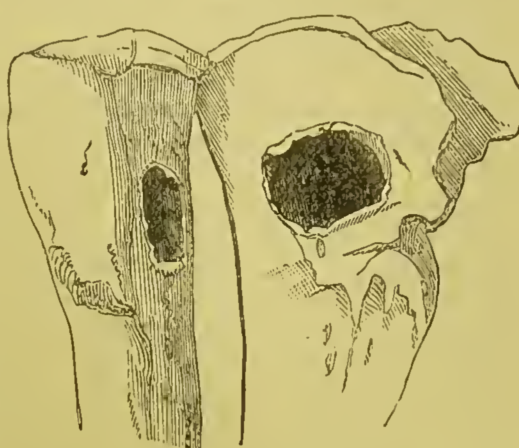
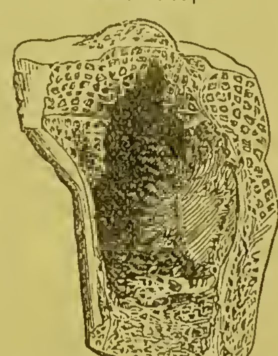


Fig. 297.†



Symptoms.—Pain is at once the earliest and most significant symptom. It is of a heavy, aching, and eventually throbbing character; more severe occasionally, or perhaps periodically—generally during the night, and persistent for a considerable period—being probably of some years' duration. This pain is referred to a particular part of the bone at one extremity—in, for example, the head of the tibia; and a point of greatest intensity can be discovered by careful palpation with the finger, where the slightest pressure produces excruciating agony. A small and slight puffy swelling, or induration, surrounds this spot; and the skin may be adherent to the periosteum,

* St. George's Hosp. Mus. † St. Thomas's Hosp. Mus., C. 5.

without presenting any discolouration. Beyond this external appearance, little or no enlargement of the bone accompanies the remarkable pain of which the patient complains; and there is an absence of any symptoms of joint-disease.

Diagnosis.—The nature of this disease may, however, be mistaken for chronic rheumatism, or periostitis; or still more probably, for a neuralgic or hysterical affection. The *persistence* of the pain is the most distinctive character of circumscribed abscess of bone.

Causes.—This abscess can, sometimes, apparently be referred to injury, or exposure to cold. The influence of tubercular disease is very uncertain. Early adult life seems to be the period most liable; but the ages in recorded cases have varied from 13 to 50. Males and females have been affected indiscriminately.

Course and Terminations.—The abscess slowly enlarging, by the excavation and condensation of the surrounding bone, never attains a large size. Ultimately, it opens into the neighbouring joint, which thus becomes disorganized; and a disposition to this result is evinced by synovial distension and swelling from time to time, after exercise. Or the abscess *may* open externally, and discharge its contents with complete relief to the previous suffering. Cicatrization follows, the cavity filling up as in the termination of other abscesses; and the fibrous material which occupies the space, probably undergoing ossification, obliterates any remnant of the abscess.

Treatment.—No topical applications or medicinal treatment have the slightest curative efficacy. But the operative proceeding proposed by Sir B. Brodie is at once simple and safe, affords immediate relief and a permanent cure. It consists in trephining the bone over the seat of abscess, and in thus giving vent to the pus. Chloroform having been administered, a crucial incision is made immediately over the painful spot externally, and extending down to the bone. A small trephine, having no projecting rim to oppose its entry, is then applied, and worked through the indurated bone; penetrating to some depth, and entering the cavity of the abscess. The circle of bone is detached and removed by an elevator or gouge, and the pus evacuated. Or a drop may appear, and the bone must be penetrated further by the gouge until the cavity is entered. Sometimes no pus is discovered on raising the circle of bone; the exposed surface should then be pierced in various directions to find a drop, and the oozing aperture freely enlarged with the gouge. Otherwise, an abscess may exist, but remain undiscovered. This misadventure happened to an experienced hospital Surgeon; the limb was amputated, and an abscess found at a small distance from the seat of perforation; showing that the removal of a small portion more of the bone would have preserved the limb. The preparation is in the Museum of St. George's Hospital. Only a small quantity of matter will issue in any case, the abscess itself being small. But the cavity having been fairly opened, the relief following the cessation of tension is instantaneous. A poultice or water-dressing will suffice during the course of reparation; which proceeding uninterruptedly, a permanent cure is established.

An error of diagnosis even may be unimportant as regards the favourable result of this simple operation. For if the disease prove to be chronic ostitis—as happened in the case of one of Sir B. Brodie's patients—the removal of a piece of bone will relieve the pain, and may induce a healthier action.

Caries, or Ulceration of Bone.—The term Caries has been applied to different morbid conditions of Bone. By some Surgeons it has been used to denote scrofulous ulceration, exclusively; and by others, to represent a morbid condition peculiar to bone, as distinguished from that of ulceration affecting the osseous texture. But the pathological identity of Caries and Ulceration is now generally acknowledged; and as such I use the term to signify Ulceration, modified only by the textural peculiarities of Bone.

Structural Conditions.—Caries is essentially a disintegration of the osseous texture; and, like ulceration of the soft textures, it may be presented in two forms—as enlarging a pus-discharging cavity or abscess in the *substance* of Bone, and as affecting the *surface* of a Bone.

Carious bone is softened, and easily breaks down under pressure with a gritty resistance; it is porous, and infiltrated with a reddish-brown oily fluid, and granular inorganic matter—the *débris* of the disintegrated texture. Small detached masses of dead bone may be found associated with the carious bone. It has a greyish, brown, or black colour, but the surrounding bone is highly vascular. Beyond and around the carious area, induration and hypertrophy may have taken place; the circumferential substance of the bone being dense, and presenting externally osseous nodules or spicula, with thickening of the periosteum.

In the *substance* of bone, the appearance of Caries is more marked in the cancellated structure, which is also more especially the seat of caries. (Fig. 298.) The enlarged cancelli are filled with the detritus, and their walls are in a softened state; the whole crumbles down under pressure with the finger, or may be readily penetrated by a probe, and yields with a grating sensation. This condition is commonly found in the cancellated portion of the bones, and as the consequence of scrofulous inflammation—ostitis. Caries usually occurs in the articular extremity of a long bone; as that of the *tibia* or *femur*, in *scrofulous* disease of the knee-joint affecting either bone; but scarcely less frequently, it attacks the bodies of the vertebræ; or the bones of the tarsus or of the carpus, in the foot or the wrist-joint.

Fig. 298.*

Fig. 299.†

On the *surface* of a bone, Caries presents a drilled, worm-eaten appearance (Fig. 299.) The periosteum is loosened or detached, thickened, vascular and villous. The projections, thus formed, pass from the under surface of the periosteum into corresponding depressions in the bone, its compact structure having acquired more the open character of the cancellous. The textural condition of the bone is similar to that already described as pertaining to deep caries. Superficial caries is, perhaps, more commonly met with in the compact portion of

* St. Bartholomew's Hosp. Mus., 1, 163. † Ibid. 1, 221.

the bone, and as the consequence of syphilitic ostitis. Thus, more often seen in the *cranial* bones, and as resulting from secondary *syphilis*, this form of caries attacks also the surface of the tibia, or of the ulna, affecting the subcutaneous parts of these bones. A somewhat significant resemblance exists between the forms of syphilitic ulceration in bone and syphilitic eruption on the skin. Thus, Sir James Paget has described *annular* or circular, *reticulated*, and *tuberculated* ulcers of bone. But these various forms are more interesting pathologically, than diagnostic.

The *Signs* of Caries are the characters of carious bone, as just described. They are not declared until abscess having formed and discharged, the bone becomes exposed, or accessible. Superficial caries is more open to examination; but the introduction of a probe will readily discover the state of the bone, both in it and deep caries. Both forms of Caries, deep and superficial, are attended with pain, more or less deep-seated, redness and swelling of the integument; followed by suppuration and the formation of abscesses. The soft parts around then present the usual characters of increased swelling, fluctuation, and discolouration. Any such abscess bursting, discloses the carious state of the subjacent bone, or leads to a carious cavity, as discovered by a probe. Fistulous openings remain, discharging unhealthy pus mixed with the granular detritus of bone. (Fig. 300.) Large, outcropping, abortive granulations spring up; and the surrounding integument has a congested purplish appearance. Caries evinces little disposition to any reparative changes.

The *Causes* of Caries are those which produce inflammation of bone, especially as occurring under the influence of some *constitutional* condition. Scrofula and Syphilis thus not uncommonly affect the bones, and in the form of Caries; the disease arising often, apparently, without any external occasion of injury as an exciting cause.

Fig. 300.*

Treatment.—The removal of any cause in operation is the primary rule of treatment in this, as in all other conditions of disease. Hence the remedial measures appropriate for Constitutional Syphilis or Scrofula will be requisite in most cases of Caries. Rest of the affected part is highly advantageous; but any topical applications, as counter-irritation by iodine, blisters, or issues, are useless, compared with constitutional treatment. In an *early stage*, the disease may thus be arrested and the bone restored to a healthy state. Or, under the influence of this treatment, disintegration proceeds only so far as to gradually remove the affected portion by a gritty discharge; recovery then taking place by granulation.

Escharotics, such as the mineral acids, caustic potash, or the chloride of zinc, have been used, or the actual cautery has been resorted to; with the view of completely destroying, and thus removing, carious bone, in order to gain a healthy surface for granulation. But little

* After Liston.

can be said to recommend, and much to reprobate, this principle of treatment. Unless in regard to quite superficial caries, any destructive application generally fails to arrest the disease, or actually provokes yet further caries, or destruction of bone.

FIG. 301.

FIG. 302.

In a *chronic* state, the disease is beyond the power of restoration, and reparation is unable to discharge the carious portion of bone piecemeal.

Operative interference, therefore, now becomes necessary. The diseased bone may be removed by excision, either of the affected portion only, or of the whole bone ; or amputation may be unavoidable, owing to the extent of the disease, or after excision, as the last resource.

Excision of the carious portion. This should always be a patient proceeding, never a "brilliant" operation. The bone having been exposed by a crucial incision, the diseased portion must be removed piecemeal by means of a gouge. Various forms of this instrument are used, according to circumstances. The ordinary scoop-gouge (Fig. 301) is generally most convenient; and Marshall's rose-head osteotrite (Fig. 302) will often prove very serviceable in finishing off a carious cavity. Care should be taken, in working with a cutting-gouge, lest the instrument suddenly slip, and be driven accidentally into the soft parts. A steady, slow movement of the hand, and grasp of the instrument almost to the point, are the best precautions against any such misadventure. The carious portion of bone yields to the gouge with a gritty resistance; whereas the sound bone remains firm, and vascular. The *extent* of bone to be removed may, therefore, be determined by these characters; portions of softened, crumbling bone should be scooped out, until the firm, rose-coloured bleeding bone is reached. The surface or cavity, having this healthy character, is then dressed or plugged lightly with wet lint, and the wound allowed to fill up and heal by granulation. In this way I have removed, more or less successfully, carious bone from nearly every bone. The whole rim of the spine of the scapula having been excised in one case, the patient—a lady of very delicate health—recovered slowly but soundly. In another case, I removed the whole of the middle third of the shaft of the tibia, excepting a shell of bone posteriorly. (Fig. 303.) Granulations, healthy and abundant, sprang up, and nearly filled up the large cavity; but the patient, by the rule of the hospital as to time, left incompletely cured, and I do not know the result.

FIG. 303.

The *articular end* of a bone—affected by Caries—may require excision, as will be fully explained in treating of Diseases of the Joints.

Excision of the *whole* bone is rendered necessary by an extent of disease beyond the range of either of the previous partial operations, in the shaft or articular end.

Amputation is justifiable only under exceptional, and perhaps extreme, circumstances; where the caries is too extensive in connected bones to admit of excision, or when constitutional exhaustion has supervened. The foot, for example, may be removed for carious disease involving the tarsal bones, with perhaps prolonged discharge. When excision has failed, amputation is necessarily the last resource.

NECROSIS.—The death of a portion of bone is analogous to Mortification of the soft parts; and it has the same pathological relation to Caries that Mortification has to Ulceration. Caries is molecular death or disintegration of the osseous texture; Necrosis, the death of a visible portion or mass of bone. Not unfrequently, both are associated in the same bone.

Structural Condition.—Necrosis—like Caries—may affect the *substance*, or the *surface*, of a bone. In the one form of necrosis, the dead portion is named the *sequestrum*, a term more particularly applicable when the piece of bone is loose and enclosed by new bone; and when limited to the deepest portion of bone around the medullary canal, the *necrosis* is sometimes named *central;* while, in the other form, a superficial scale-like portion of dead bone is designated an *exfoliation.*

FIG. 304.*

Necrosed or dead bone is smooth or rough, hard and white; becoming brown or black, and softened, when exposed to the action of decomposing pus and the air, from sloughing of the integument. It is avascular, not yielding any blood when wounded, and insensible.

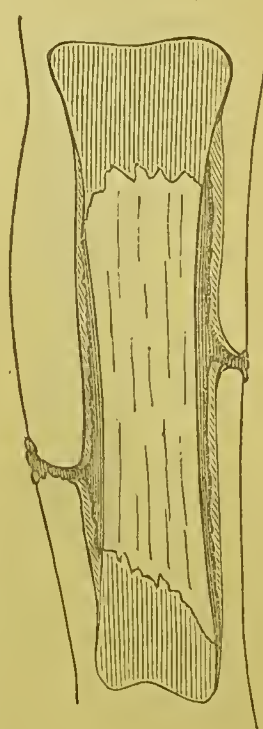
Reparation.—The *whole substance* of a bone, or its *central* portion only, may be necrosed; in point of extent also, the whole length of the shaft of a long bone may be dead, and occasionally even the epiphyses are involved. But the process of reparation will be typically described by reference to that form of necrosis in which the whole substance, or thickness, of the shaft of a long bone, *e.g.*, the tibia, is necrosed; and as consequent on acute ostitis. The periosteum, at first adherent, soon loosens its connection with the subjacent dead bone, and deposits ossific lymph between itself and the surface of the bone. This lymph-deposit undergoing ossification, forms a sheath of new bone over or around the dead portion, which thus becomes enclosed in an osseous case. The periosteum is the chief, but not the only, source of osseous reproduction in necrosis. The instructive specimen here represented, exhibits the periosteal production of new bone in the tibia of a boy, after necrosis of a large extent of the whole thickness of the wall. The outer surface of the sequestrum is quite smooth, the periosteum having separated without any portions of bone being attached to it. On the inner surface of the detached periosteum—the external dark line being

* St. Bartholomew's Hosp. Mus., 1, 133.

the periosteum—a layer of new bone, half an inch thick, and forming almost a complete new wall to the tibia, has been produced. (Fig. 304.) The outer surface of this new bone is covered by the old periosteum, the continuity of which with that of the articular ends is shown; and the inner surface of the new bone is lined by a soft vascular membrane, which was in close contact with the outer surface of the dead bone. But observation has shown that the original bone itself is an important source of new bone—by granulation—in the absence of the periosteal membrane, or in central necrosis; and that the medullary membrane may contribute its share. The articular ends, in particular, evince a remarkable ossific power, when the shaft of a long bone is removed. I have seen an inch and a half of the shaft of the tibia thus reproduced. Apart from the periosteum, when this texture is destroyed, the soft tissues around the bone may acquire the power of forming ossific deposit. The dead portion, at first continuous with the healthy bone at either end, loses its connection at the line of continuity; the living bone detaching itself from the dead. Ulceration takes place in the course of that line, the purulent discharge containing $2\frac{1}{2}$ per cent. of bone-earth, phosphate of lime, as shown by Mr. B. Cooper; or interstitial granulations are produced, by which a slight amount of bone is consumed, as Billroth states. A groove is thus formed around the junction of the dead portion of bone (Fig. 305); and this groove deepening, at length completely detaches it. Pus collects around the sequestrum, and interrupting the complete formation of the periosteal sheath of new bone, leaves apertures therein—one or two to four or five in number—the *cloacæ*, through which sinuous tracks between the sequestrum and fistulous openings in the integument become established. (Fig. 306.) These orifices pout with large, abortive granulations. This twofold process goes on simultaneously, though not perhaps equally; constituting a *separation* of the living from the dead bone, and *reparation*, chiefly by the periosteal reproduction of a cylinder of new bone enclosing the dead portion. Both changes are slowly progressive, extending over a period of weeks or months. But at length the *sequestrum* becomes complete, and ensheathed by the cylinder or *involucrum* of new bone. (Fig. 307.) This latter is highly vascular, and of a bright red colour; although, when dried as a "pathological preparation," the new bony case is whitish brown, rough, and porous. It is perforated with apertures—the *cloacæ*, unlike the enclosed sequestrum of dead bone; which—in a specimen—may be further recognized, through the cloacæ, by its white colour, smooth and firm

Fig. 305.*

Fig. 306.†



* St. Bartholomew's Hosp. Mus., I, 23.

† Diagram from Billroth.

surface, or sometimes having a brown or blackish appearance, and a softened or soddened consistence, from exposure to decomposing pus-maceration. The cloacæ are formed apparently, as Troja observed, in consequence of deficient periosteal deposit, in small spaces, here and there, during the production of the new bony case. The apertures thus left are Nature's provision for the exit of the enclosed sequestrum of dead bone, and for the free discharge of matter.

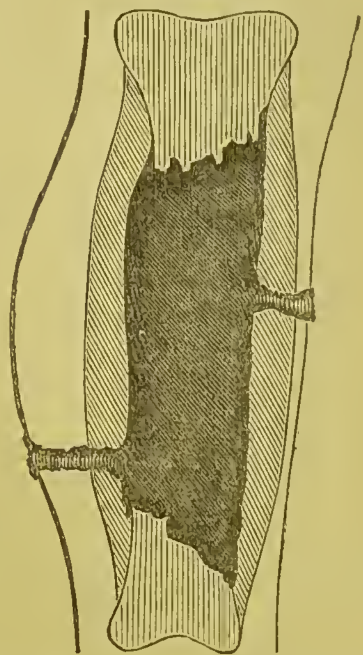
Fig. 307.*

The *sequestrum* is of smaller size, in length and breadth, than the involucrum of new bone, in which, therefore, it lies loose after its detachment. This diminution of the dead portion in length results from ulcerative disintegration, or from absorption by interstitial granulations in the living bone, during the process of disjunction; and afterwards, reduction may be effected, in length and breadth, through the medium of granulations, which spring from the whole inner surface of the osteo-plastic cavity — the bone-ends and periosteal sheath; absorption being aided, perhaps, by the pressure also thus brought to bear upon the sequestrum. The doctrine of bone-absorption by granulations, and thence, moreover, the reduction of the sequestrum, *after*, as well as before, complete separation, was originally maintained by John Hunter; and the results of observation by Velpeau, Lawrence, and Billroth have afforded corroborative evidence; while Stanley, Gulliver, and Liston were led to the opposite conclusion. Rokitansky attributes any apparent absorption to ichorous corrosion and liquefactive discharge. The influence of close contact—apart from the agency of granulations—is shown by the partial disappearance of ivory pegs, when imbedded in living bone. In consequence of progressive absorption, the imprisoned or attached surface of the sequestrum at length acquires a *rough*, or worm-eaten, and irregular appearance, and the margins become serrated or spiculated; resulting from the close adaptation of the encompassing granulations. Hence, any uncovered part of the sequestrum is not subject to absorption, and remains smooth; so also, when the granulations suppurate, absorption ceases, for then the surface is no longer in contact. Nature thus attempts to bring about *extrusion* of the sequestrum, as a foreign body. Having separated by ulcerative disintegration, or by absorption

* Museum, Royal Free Hospital.

from the living bone through interstitial granulations, the dead and detached portion of bone is reduced in size, and loosened, by absorption, through the medium of encompassing granulations, and subjected to the expulsive compression of granulation-growth. When removed, the sequestrum-cavity remains. (Fig. 308.)

Fig. 308.*



The *involucrum*, or sheath of new bone, is the scene of certain formative changes. It increases in thickness, the longer the enclosed sequestrum remains as a source of osteo-plastic irritation; so that, in the course of years, the bony case might become more than half an inch thick. Losing its rough and porous character, it gets smoother and more compact or stronger, yet somewhat thinner; thus altogether more nearly resembling the natural shaft of a long bone. The cloacæ, having served the temporary purpose already noticed, become smaller; but whether they are ever entirely closed seems doubtful. When the sequestrum has been discharged, perhaps, in the natural course of necrosis, or has been extricated and removed by surgical interference—in either case, the cloacæ providing apertures of exit—the osteo-plastic cavity may continue to granulate and ossify, and thus still more completely restore the original substance of the shaft of bone. But whether the medullary canal be reproduced, as after the reparation of fracture, is as yet undetermined; although, from analogy, this final result is not improbable. If, in the production of the new bone-shaft, any muscles lose their attachments, they regain new points of insertion, and are thus admirably enabled to resume their respective actions.

Modifications of Necrosis.—Certain *deviations* from the normal course of Necrosis—which Prof. Billroth has observed—are worthy of notice; as relating to the detachment of the sequestrum, and the formation of the involucrum of new bone. In young persons, affected with acute periostitis, the epiphyseal cartilages of a long bone may undergo *ossification*, although rarely, at the upper and lower ends of the bone simultaneously; but then the sequestrum will be detached very early, before the new bony case can have completely formed. If, therefore, the sequestrum were removed at this period, the limb would be weakened, and remain weak, owing to removal of the foreign body, which, as a source of irritation, induces osteo-plastic deposit. *Suppuration* of an epiphysis is also attended with early detachment of the sequestrum at that end; and this event may lead to such displacement and projection, by muscular action, that perhaps the bone protrudes through the integument; instances of which have occurred, with regard to the femur, at the knee-joint, and the humerus, at the elbow. In such cases, destruction of the joint will probably be inevitable.

* Diagram from Billroth.

Partial Necrosis.—Various forms of partial necrosis sometimes occur. In the shaft of a long bone, necrosis may be limited to the walls, to a portion of bone within the walls, or to the cancellous structure, as a completely central necrosis. Such cases are rare. I shall, therefore, best draw attention to their existence by referring to certain valuable specimens in the Museum of St. Bartholomew's Hospital, and as described in the catalogue, respecting each such form of partial necrosis.

(1.) Necrosis limited to the *Walls* of a long bone.—Sections of a Tibia (Fig. 309), of which nearly the whole length and thickness of the walls of the shaft perished, and were in process of separation from the cancellous and medullary texture, which has preserved its vitality and a nearly healthy condition. The groove formed between the dead and the living bone is filled with soft and very vascular granulations. On the internal surface of the periosteum, spongy and vascular new bone is formed in a nearly uniform layer, to supply the place of that which has perished. The inner surface of this new bone is covered by vascular granulations.

FIG. 309.*

The walls of the bone perished after inflammation of the periosteum, produced by the application of nitric acid to a sloughing ulcer in the front of the leg.

(2.) Necrosis *within* the *Walls* of a long bone.—Section of a Tibia (Fig. 310), in which large portions of the wall are separated after necrosis. The separated portions include only the middle laminæ of the wall; the outer laminæ are entire, except in so far as they are perforated anteriorly, and the inner laminæ appear only somewhat thickened and less compact than is natural. The sequestræ thus lie in cavities between the separated internal and external laminæ of the wall, which cavities open by four nearly round apertures through the anterior and inner wall.

FIG. 310.*

The patient was a feeble young woman, twenty-two years old, in whom the necrosis had existed more than a year before she died with pulmonary disease. About six months before her death, the existence of necrosis being suspected, in consequence of the large quantity of pus discharged through two minute apertures in the front of the tibia, a portion of the bone was removed by the trephine, and some sequestræ were extracted. The patient benefited by the operation for a time; but the openings into the cavities containing the other sequestræ remained, and were only narrowed by the growth of new bone around them. The case is related by Mr. Stanley in his "Treatise on Diseases of the Bones," pp. 138–9.

In the specimen of necrosis figured from the Museum of the Royal

* St. Bartholomew's Hosp. Mus., 1, 19. † Ibid, 1, 268.

Free Hospital, (p. 688), it will be observed that a similar partial necrosis has occurred; a small sequestrum lying within the wall of the upper portion of the Tibia. There is also a very remarkable specimen in the Museum of the Royal College of Surgeons: a lower jaw, with a very small sequestrum lying within the body of the bone, which at that part is greatly thickened and indurated; externally, the circular mark of a trephine shows that an attempt had been made to reach a suspected sequestrum or abscess, which doubtless had been attended with prolonged suffering during the surrounding ostitis.

FIG. 311.*

(3.) Necrosis of the *cancellous* structure within the shaft of a long bone.—Section of the upper part of a Tibia (Fig. 311), in which portions of the cancellous tissue have suffered necrosis and are partially separated. Lymph and pus are diffused upon and within the dead portions of bone; the medullary canal contains them alone, the rest of its osseous and fatty tissue being removed. The walls of the tibia are thickened and penetrated by several apertures into the medullary tube. The disease is limited to the shaft of the tibia; its head is healthy. From an old man, in whom the disease had existed more than twenty years.

Necrosis without Suppuration.—Necrosis is not invariably followed by suppuration. Mr. Stanley drew attention to this fact,† and it has been confirmed by Sir James Paget, who has recorded two examples of what he proposes to term "quiet necrosis." ‡ Mr. Morrant Baker has, however, shown that much more extensive necrosis than that to which the term *quiet* necrosis is applicable may occur without the formation of pus; and he has recorded a case § in which nearly the whole femur perished, and at the time of the amputation of the limb, about three months after the commencement of the disease, not a drop of pus could be discovered. Mr. Baker supposes that this apparently strange deviation from the ordinary course of cases of necrosis is due to the fact that the death of the bone occurs in the course of chronic ostitis; the shaft of the bone gradually dying as its sources of blood-supply are cut off, partly by inflammatory changes within it, and partly by the formation of new bone in and beneath the periosteum and endosteum. It might be expected, under such circumstances, that suppuration would be long delayed; and he suggests that if there were more frequent opportunities of examining, by section at an early stage, bones affected by chronic ostitis, deep-seated necrosis would be not infrequently found. As it is, however, no need commonly arises for operative interference until the presence of suppuration has removed the necrosis from the list of unexpected occurrences. Mr. Morrant Baker suggests the term *intra-osseous* for that variety of necrosis in which the dead bone is enclosed by new bone on both its outer and inner aspects; this new bone having been

* St. Bartholomew's Hosp. Mus., 1, 267.
† "A Treatise on Diseases of the Bones," 1849, p. 83.
‡ "Trans. of Clinical Society," vol. iii.
§ "Trans. Medico-Chirurgical Society," 1877.

produced by both the periosteum and the medullary membrane, or endosteum. In ordinary cases of necrosis of the shaft of a long bone, the sequestrum is surrounded by a sheath of new bone, which has been formed by the periosteum and, it may be, other structures external to it; the medullary membrane perishing with the bone which encloses it. In cases of *in tra-osseous* necrosis, on the other hand, new bone is produced by the endosteum as well as the periosteum; and the sequestrum is thus often so completely "locked" as to render its removal almost an impossibility; the difficulty being increased by the frequently long-delayed separation, under these conditions, of the dead from the living bone.

Diagnosis.—Necrosis unattended with suppuration may simulate malignant disease, in the formation of a large tumour or swelling, which is hard and incompressible; spontaneous fracture also sometimes takes place, and yet this event may not, for at least many weeks, be followed by suppuration. Mr. Baker relates a case of this kind, in which the femur was the seat of chronic osteal inflammation, and the swelling extended below nearly to the knee-joint and above to the trochanters. Spontaneous fracture took place, followed by deformed union. But the patient gradually lost flesh and was worn out by pain and sleeplessness. Under these circumstances, the limb was amputated at the hip-joint, and a rapid recovery ensued. Section of the femur then revealed the above condition of necrosis, not a drop of pus being found.

Exfoliation, or superficial necrosis, presents the same appearances as to the state of the dead portion of bone. But it results generally from the destruction of the periosteum; consequently, no periosteal sheath of new bone is produced. The plate of dead bone is detached —as in deep necrosis—by linear ulceration forming a groove circumferentially; but the detached portion not being ensheathed by new bone, it is thrown off from the surface or exfoliated, and exposed by open abscesses or sloughing; or it can be easily removed surgically by forceps. The separation of an exfoliated portion of bone, like the detachment of a sequestrum, is always a slow process; in one case, after compound fracture of the tibia, in a healthy boy, I removed a thin scale of bone, about an inch square, on the day four months from the time of the accident. The periosteum of the *cranial* bones—the pericranium—even when uninjured, does not seem to have the power of forming a sheath of new bone; and thence the same result ensues—exfoliation. (Fig. 312.) The dura mater is nearly equally unproductive—within the skull.

FIG. 312.*

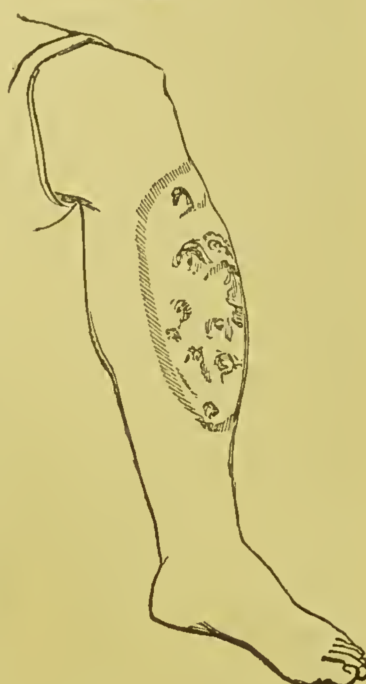
The *Signs* of Necrosis are the characters of necrosed bone, as already described. But—as with Caries—these characters are not declared until, abscess having formed and discharged, the bone becomes exposed or accessible. The introduction of a stout probe will readily

* St. Bartholomew's Hosp. Mus., A. 90.

discover the rough, loose sequestrum; or, when visible, it may be recognized by its dead-white appearance, or blackened by decomposing purulent discharge. Exfoliation is more open to examination.

Necrosis is attended with violent and deep-seated pain, considerable redness, and swelling of the surrounding soft parts. Suppuration ensues sooner or later, in consequence of inflammation of the bone—ostitis—having led to and being connected with the necrosis, or as the result of prolonged irritation of the sequestrum, itself a foreign body. The matter discharged through the fistulous openings is usually sanious, dark coloured, and fetid, although sometimes it has the thick, yellow character of healthy pus; especially in necrosis arising from an external cause, as compound fracture, and with a healthy constitution. The extent of the sequestrum will be fairly declared by the boundary of the integumental swelling, and by the spaces between the cloacæ (Fig. 313), when a probe is introduced. The fever, which had been that of inflammation, during the previous ostitis, assumes an irritative character, when bone becomes necrosed; and suppuration, with prolonged purulent discharge, is attended with hectic and great exhaustion. Unlike caries, necrosis occurs more frequently in the shafts, than in the articular ends, of long bones; and more often in the compact, than in the cancellated structure, of any bone. This difference of liability is due apparently to the lower degree of vascularity, and of vitality therefore, in the compact osseous texture. Every bone is subject to necrosis, but certain bones are more commonly affected: the tibia, femur, humerus, ulna, radius, clavicle, lower jaw, upper jaw, scapula, and cranium. In the flat bones, last named, necrosis usually takes the form of exfoliation.

Fig. 313.



Central necrosis is necessarily more obscure, owing to the depth of the morbid condition. The symptoms resemble those of chronic abscess in the substance of bone. Deep-seated and, perhaps, throbbing pain, with some swelling of the bone, or puffiness over a particular spot, are the more characteristic symptoms, and their persistence is even more significant.

Causes.—*External* and *traumatic* causes seem to have a more absolute effect in producing necrosis, unaided by any predisposing constitutional influence, than in relation to caries. Any injury detaching the periosteum will probably be followed by more or less necrosis; excepting in the cranial bones, or others which are highly vascular. Violent contusion may so damage the osseous texture and medullary membrane as to produce necrosis. Severe cold, as in frost-bite, and deep burns are also immediate causes. Powerful irritants have a marked effect, apart from any inflammatory action. Thus, the fumes of phosphorus, in lucifer-match manufactories, often produce necrosis of the lower jaw; this powerful irritant entering the bone, apparently, through

carious teeth. Any form of inflammation of bone—ostitis, periostitis, or osteo-myelitis—may also induce necrosis.

Constitutional causes are, however, very influential; sometimes predisposing to, or frequently producing, necrosis. Scrofula, syphilis, and formerly the excessive administration of mercury, represent this class of causes; but necrosis occasionally results from typhoid fever, scurvy, and other exhausting diseases.

Consequences.—*Continued suppuration* accompanies necrosis, and in proportion to its extent. The matter burrows among surrounding muscles, and disorganizes the whole substance of the part; while the numerous sinuses opening externally and communicating with the bone, continue to discharge an unhealthy pus. Large, protuberant granulations, springing up around the orifices of these passages, evince an abortive tendency to close up the soft parts; but reparation of the bone, by the formation of a periosteal sheath, is far more active. Albuminuria, and amyloid degeneration of the liver, are not unfrequent constitutional consequences of prolonged suppuration. Certain *accidents* are, however, liable to happen in the course of repair. As, in a long bone, like the femur, the ensheathing cylinder of new bone acquires strength at about an equal rate of progress to that of the disjunction from the sequestrum, the firmness of the limb will be maintained; but if consolidation fail, then, subject to muscular action and the weight of the limb, *fracture* may take place; or, the new bone undergoing some alteration of shape and direction, the limb becomes *deformed* and *shortened.* But either of these events will depend very much on an insufficient length of sequestrum, within the new bony sheath, to support the limb; or on the want of sufficient support from a side bone, as the fibula in relation to the tibia, when the shaft of this bone is necrosed. The ulcerative detachment of the dead portion of bone, sometimes extends to a large vessel, or the point of the sequestrum may be driven into an artery in some movement of the limb; giving rise to serious *hæmorrhage* externally, or to the formation of *aneurism.* But these perilous consequences are rare. The new bone which substitutes a necrosed portion of bone, may itself be attacked with necrosis; in which event, any repair will be very defective.

Treatment.—The removal of any cause in operation must be the primary consideration. *Traumatic* causes, which have already expended their force, so to speak, in producing necrosis, are obviously not under control. But, as arising from detachment of the periosteum, exfoliation may sometimes be prevented by timely replacement of this vascular membrane; or if adhesion takes place between the bone and adjoining soft parts, or granulations spring up from the surface of the bone, a new periosteum will be gradually formed.

Constitutional causes cannot be altogether overcome, but their full effect may be prevented. Hence, the medicinal treatment appropriate for scrofula, or constitutional syphilis, proves very beneficial in most cases.

Suppuration and *abscess* must be treated on ordinary principles; while the accompanying hectic, or the constitutional irritation arising from the presence of dead bone, should be supported by a tonic and stimulant plan of treatment with nourishing diet.

Sequestrotomy.—*Extraction of the sequestrum.*—The dead portion of bone is a foreign body. Unless, therefore, it be thrown off by Nature,

it must be removed by Art. Its removal is determined, both in point of time and the extent of dead bone to be removed, by the ulcerative line of demarcation and the detachment of that portion; a process of some weeks' or months' duration, and the progress of which should be ascertained, from time to time, by examination with the probe. The sequestrum may have become completely detached from the living bone, but yet remain fixed by adhesion to the granulations which closely penetrate its worm-eaten surface; so that it will perhaps be necessary to ascertain whether the piece of dead bone can be made to move a little upwards or downwards, by gentle pressure alternately between two probes, introduced into cloacæ, at some distance apart. A loosened sequestrum, imprisoned within a sheath of new bone, can only be extricated by surgical interference. The operation consists in cutting down upon the bone, and extracting the sequestrum, by means of serrated bone-forceps. (Fig. 314.) In making the incision, advantage is taken of the course of the fistulous tracks leading to the cloacæ in the bony case; and then the latter apertures are made available for removal of the sequestrum. The cloacæ are usually found at the lower part of the bony case; but they communicate with the cavity containing the sequestrum by osseous canals, of variable extent, and which have a more or less oblique direction upwards. Narrowed internally, and expanded somewhat outwards into a funnel shape, the apertures are round or fissured, and of small size—generally not larger than would admit a small quill or a probe. Sometimes, one

Fig. 314.

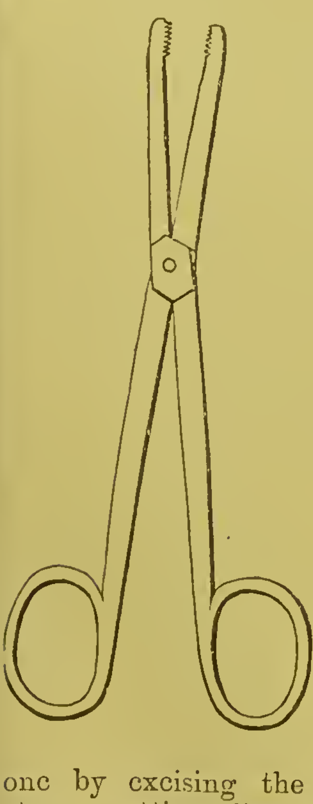
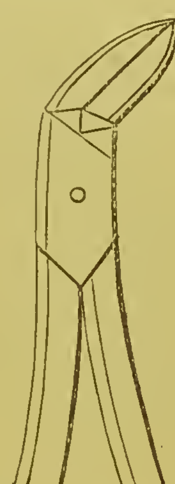


Fig. 315.

Fig. 316.

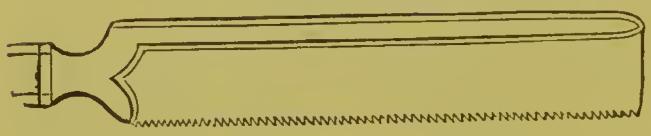


of the cloacæ is sufficiently large to allow of the extraction of the sequestrum through it. Or the cloaca may be enlarged, or two such apertures thrown into one by excising the intervening portion of the bony case with strong cutting-pliers, straight or angular bladed. (Figs. 315, 316.) The sequestrum may perhaps be pushed upwards or downwards, so that one end can be seized with the forceps, and thus the whole

be withdrawn. Or again, it may be more convenient to divide the sequestrum by the same instrument, and extract either fragment separately; or, by removing a central portion, either end-piece may be extracted. The removal of any portion of the bony case is undesirable, as the new bone is not reproduced, and the limb would remain proportionately weakened; care also must be taken not to damage the interior of the sheath. The cavity of the new bone, usually single, is sometimes multilocular, and each interspace may contain a sequestrum. Hæmorrhage occurs freely during this operative procedure; the blood springing from the vascular soft parts around, or welling up from the new bone. It can generally be arrested by pressure; but in this, and other operations on bone, the Surgeon will find the advantage of Esmarch's elastic ligature around the limb, previously emptied of blood by means of the elastic roller. The bottom of the wound should be lightly dressed with lint; any inflammation consequent on the operation must be subdued by ordinary treatment; and eventually the limb should be supported by a starched bandage until granulation is complete, and the bony case has acquired sufficient strength to bear the weight of the body or the movements of the part. I have thus, from time to time, removed several loose sequestra from the lower half of the shaft of a femur; guided by the sinuses, and preserving the osseous case which had formed around the bone. In a compound fracture of the tibia with death of the periosteum, the end of the upper fragment, to an inch and a half in extent, separated as a sequestrum, which I removed, together with several small scaly and spiculous portions from the lower fragment. Union ensued, but imperfect consolidation; a slight hinge-like mobility remaining for some months. An *exfoliation* may be thrown off naturally; but this process will be much facilitated surgically by incisions, when the dead portion has separated.

Excision of the *whole* of the bone necrosed, or short of its *articular* end.—This operation may, occasionally, be had recourse to in *extensive* necrosis. Thus, the lower jaw has not unfrequently been removed for necrosis caused by the fumes of phosphorus. The entire shaft of the radius, leaving its articular ends, was excised by Mr. Savory, on account of necrosis; and afterwards, the bone was reproduced from either end to such an extent, that in eight months there remained an interval of only an inch and a half, and this appeared to be gradually diminishing. The fibula also has been excised. Removal of the ungual phalanx of a finger, for necrosis from whitlow, has proved perfectly successful in preserving the end of the finger. These results are sufficient to encourage the practice of excision in other cases of extensive necrosis. In operations for bone-excision, in necrosis, as of the lower jaw, a short, narrow-bladed saw will often be found very convenient. (Fig. 317.)

Fig. 317.

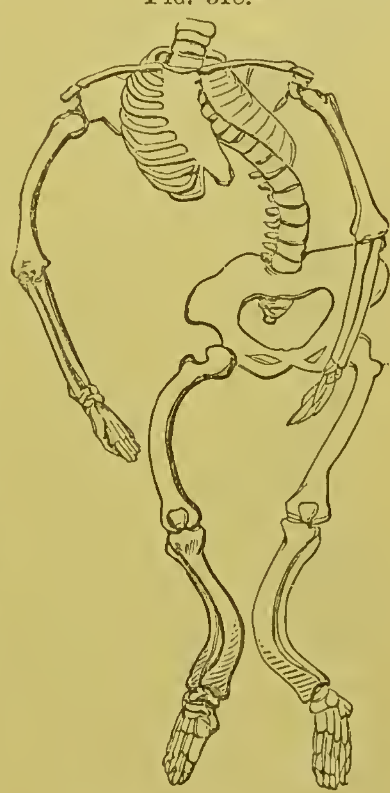


Amputation must be regarded as an extreme resource, but justifiable as a sacrifice of the limb for the preservation of life. In necrosis involving the neighbouring joints, or where the limb has become

disorganized by prolonged and profuse suppuration, or the general health undermined by hectic, amputation is unavoidable. Thus, in a case of necrosis of the femur consequent on typhoid fever in India, the whole shaft of the bone was involved, the limb enormously thickened, and the muscles were matted together. I amputated the limb close to the trochanter, and the patient made an excellent recovery, regaining his general health. And in the more rare cases, also, where a main artery is opened by ulceration, or wounded by the sequestrum, amputation will generally be preferable to ligature of the vessel, *in situ*, or by the main trunk.

Rachitis or Rickets.—*Structural Condition.*—This disease affects more or less the whole osseous system. The earthy matter of the bones is diminished, and the organic basis, therefore, proportionately increased; the cancelli are enlarged and filled with a brownish-red fluid. Both the periosteal and the medullary membranes appear to be more vascular than in health, and the former membrane becomes thickened. All these changes are more marked at the epiphyseal ends of the long bones. The flat and the short bones, particularly the carpal and tarsal bones, are thickened. Some relaxation of the ligaments accompanies the change of osseous texture. Bones in this state have acquired great softness and flexibility, thence undergoing remarkable changes of shape, in consequence of the weight of the body, or other forces to which they are subject. The bones of the limbs, in particular, become curved inwards or outwards and distorted, the pelvis collapsed and twisted, the thorax contracted above and enlarged lower down by the dragging weight of the abdominal viscera, and the spine is often distorted by lateral or other curvature. The cranium appears enlarged, owing perhaps to the imperfect development of the facial bones; presenting a large head and diminutive face. There is also a general arrest of growth and development.

Fig. 318.*



The *Signs* of rickets are some of these peculiar deformities of the osseous system. They are found often also in connection with manifestations of scrofula. Perhaps the earliest observable deformity is a swelling of the wrist, due to enlargement of the carpal epiphyseal ends of the radius and ulna. The knee and ankles often present enlargements in like manner. Deformities of the bones soon follow, and in the order, generally, as Guérin observes, from below upwards. Under the weight of the trunk, the tibia and fibula of both legs are curved outwards and forwards, the arches of the feet yielding and turning inwards; with this excurvation of the legs, the knees also are bowed outwards, accompanied

* St. Bartholomew's Hosp. Mus., A. 148.

perhaps with some excurvation and bending forwards of the femurs, and corresponding deformities of the thighs; thus altogether presenting the rickety and bandy-legged appearance familiar to experience. Sometimes, the opposite curvatures take place: incurvation of the legs and of the thighs, with a knock-kneed condition, and flat feet everted. (Fig. 318.) Occasionally, the curvatures have an opposite direction in the two limbs; a general excurvation on one side, with incurvation on the other side. When the child crawls about habitually on his hands and knees, the bones of the upper extremities are no less liable to deformities, and at an early period. The constitutional symptoms are those of general debility, evinced more especially by night-sweats, affecting the head in particular, with a remarkable tenderness or sensitiveness of the whole cutaneous surface of the body.

The *Causes* of this disease are obscure. It would appear to be a condition of imperfect formation of the osseous texture; rickets never arising after the bones have become fully ossified and consolidated; nor, indeed, after the age of puberty. It is a disease of childhood or infancy, and possibly commencing in fœtal life; although its results remain in the adult. As arising from mal-nutrition, rickets is eminently a constitutional disease, although manifested principally in the osseous system. Thus, observes Sir W. Jerner, it is no more a disease of the bones than is typhoid fever a disease of the intestines.

Consequences.—In an early stage, before the disease is established, rickety deformities may disappear under favourable hygienic circumstances and treatment. At a later period, the bones become strengthened by *osseous deposit* in the parts most requiring support; the long bones acquiring increased thickness in their small curvatures, and the deposition extending even into the interior, so as to partially obliterate the medullary canal. (Fig. 319.) The epiphyses become thickened at the wrist, giving the appearance of a "double-joint," owing to a second depression in the skin, above the radial epiphysis. Nodular enlargements form on the anterior ends of the ribs, at the junction of the costal cartilages; and lying regularly one under another, they present the appearance named the "rachitic rose-garland."

FIG. 319.*

Unlike the tendency to periostitis and ostitis, in scrofula, rachitic periosteal and osteal thickenings never end in suppuration. *Fracture*, and more often incomplete or green-stick fracture, is liable to occur; but bony union generally takes place, and in the usual period.

Treatment.—The primary indication obviously is, to supply the deficient earthy matter; and so, probably, arrest the disease. But no known medicinal preparation seems to have this effect. The phosphates of lime, or lime-water, have been administered; but in several instances I tried them without any perceptible result. Iron and quinine, combined with cod-liver oil, often prove more beneficial. These medicinal tonics, with due regulation of the bowels, nutritious diet, pure air, sea-bathing, frictions, and other means for improving the general health, constitute the most effectual plan of treatment. The nitro-muriatic acid

* St. Bartholomew's Hosp. Mus., 1, 35.

bath is much recommended by Sir Ranald Martin, as a valuable adjunct. Daily exercise may be taken advantageously; but the bones of the lower limbs should be relieved from the weight of the body, by the patient reclining at intervals during the day, and wearing steel-supports so applied as to resist any tendency to curvature. The support should be placed on the opposite side of the limb to the direction of curvature. When applied upon the curve, observes Mr. Brodhurst, pressure should be exerted only in the horizontal position, to avoid sloughing. Many a little, rachitic child, pot-bellied and bandy-legged, may thus be reared to man's estate; when Nature will complete the cure. Permanent curvatures in the long bones may remain, after the osseous texture has become strengthened by ossific deposit, and acquired perhaps sclerotic hardness. Any such deformity, if it interfere with the use of the limb, may resist mechanical treatment by means of properly contrived apparatus. It has, therefore, been proposed to fracture the bone subcutaneously, and then set the limb straight; or, if the bone be too firm, to perform subcutaneous osteotomy, as Langenback recommends. Successful results have been obtained by both these surgical procedures. But the probability of a natural cure taking place should ever be remembered; that the bones will straighten in their growth, the child out-growing the deformity.

Mollities Ossium—Osteomalacia—Malacosteon.—*Structural Condition.*—This diseased state of the bones is far more rare than rickets, only a few instances having been recorded; but it is also far more serious. The earthy matter is greatly diminished, but replaced by a peculiar reddish gelatinous matter, chiefly fatty, and containing nucleolated nuclear cells, which have been described by Mr. Dalrymple.

Fig. 320.*

This matter occupies the cancelli, which are considerably enlarged, and cavities in the compact texture; infiltrating the whole substance of the bone, until, as Dr. Ormerod remarks, it more resembles fatty matter enclosed in a periosteum than a bone. Bones thus affected are soft and flexible; on section, the osseous texture yields a gritty sensation, and has a reddish-brown or maroon colour, exhibiting the peculiar gelatinous matter in an extremely rarefied osseous texture. (Fig. 320.) The characteristic appearances are well-marked in the section of the lower half of the femur, as represented. Atrophy, by rarefaction of the cancellous texture, and thinning of the walls of the bone, is associated with the substitution of the peculiar gelatinous and fatty matter. The periosteum and articular cartilage are healthy. The chemical composition of bone in this state, according to Dr. Leeson's analysis, is—in 100 parts, 18·75 animal matter, 29·17 phosphate and carbonate of lime, and 52·08 water.

Commencing, apparently, in the cancellous tissue, the compact portion may retain its natural consistence, as an outer shell of bone; and the whole length of a long bone may not be affected. But many bones are always simultaneously diseased. Fracture, or bend-

* St. Bartholomew's Hosp. Mus., 1, 233. See also Specimen 1, 129.

ing without fracture, ensues, according to the extent of the disease. When softening is limited to the *internal* part of the bones affected, leaving an outer shell of hard bone, fracture is liable to occur; in one case, related by Tyrrell, twenty-two fractures happened; in another, by Arnott, thirty-one fractures. When the disease involves the *whole thickness* of the bones, they become bent in various forms, and to an extreme degree; presenting the most remarkable and frightful deformities. (Fig. 321.)

Fig. 321.*

Mollities ossium and Rickets have some structural characters in common; the marked diminution of earthy matter, and rarefaction of the osseous texture; both diseases also affect more or less the osseous system generally. But the gelatinous matter is peculiar to mollities ossium. In respect of its fatty character, the disease has some affinity to fatty degeneration; while, in virtue of the nuclear and nucleated cells, a few of which may be caudate-shaped, there would appear to be some alliance to the structural elements of Cancer. As compared with *senile* atrophy of bone, mollities ossium is distinguished by the softness of the osseous texture, as well as by the medullary canal being filled with the peculiar gelatinous substance, and which also occupies the place of the compact walls of the bone, now reduced perhaps to a mere shell. Otherwise, the thin bony case resulting from senile atrophy so far resembles, and might be mistaken for, the atrophy which accompanies mollities ossium.

Signs and Symptoms.—Certain premonitory symptoms usually precede fracture or deformity from mollities ossium. Wandering pains in the affected bones are experienced, and of a rheumatic character, but more severe and persistent. Marked failure of the general health accompanies these osseous pains; while great exhaustion and some emaciation precede any perceptible change in the bones. Then a fracture here or there, and progressive deformity, leave scarcely any doubt as to the nature of the disease.

Diagnosis.—From *Rheumatism*, it is at once diagnosed by these manifestations of morbid osseous condition; from *Cancer*, by the very general distribution of the disease, affecting more or less the whole osseous system, and by the deformity. Thus, according to Litzmann, in 85 child-bearing women, the whole skeleton was affected in 6 cases, and all the bones except those of the head in 2; and in 46 other cases, all parts of the skeleton were diseased in 21, and all the bones except those of the head in 6. From *Rickets*, as well as other diseases, Mollities Ossium may be distinguished by another symptom. The state of the *urine* is peculiar. It contains a great abundance of earthy

* "Med.-Chir. Trans.," vol. xxvii. Mr. Solly's case.

matter, which was shown by Mr. Solly to be phosphate of lime, removed from the bones and eliminated through the kidneys. But the urine may also contain a peculiar substance, nearly allied to albumen, and in great abundance. According to the analysis of Dr. Bence Jones, in Mr. Dalrymple's case, this substance is the hydrated deutoxide of albumen, and 66·97 parts were passing out of the body in every 1000 parts of urine. Here, therefore, there was as much of this albuminous substance in the urine, as there is of ordinary albumen in healthy blood; an ounce of urine passed was equivalent to an ounce of blood lost, as regards its albumen. "The peculiar characteristic of this hydrated deutoxide of albumen was its solubility in boiling water, and the precipitate with nitric acid being dissolved by heat and reformed when cold. By this reaction a similar substance in small quantity may be detected in pus, and in the secretion from the vesiculæ seminales. The reddening of the urine on the addition of nitric acid might perhaps lead to the re-discovery of this substance; when found, the presence of chlorine in the urine, of which there was a suspicion in the above case, should be a special subject of investigation, as it may lead not only to the explanation of the formation of the albuminous substance, but to the comprehension of the nature of the disease which affects the bones."

Causes.—The pathological cause of mollities ossium is unknown. But the disease in no way arises from an imperfect formation of the osseous texture, and does not generally occur before the middle period of life, or subsequently; thus, also, differing from rickets. It would appear to be hereditary, in some cases. Females are more subject than males, and repeated pregnancy seems to engender a predisposing condition.

Termination.—The fractured bones evince little or no tendency to the formation of callus; and as the deformity resulting from their bending increases, the patient becomes a wretched cripple, yet living perhaps for years. Ultimately, death ensues from sheer exhaustion; or functional disturbance, consequent on altered relations of the viscera or pressure from deformity, proves fatal.

Treatment.—No known medicinal agents have any curative efficacy. A generally tonic and nourishing plan of treatment may somewhat relieve the concomitant exhaustion of mollities ossium, and opiates alleviate the wearing pains. Posture and mechanical contrivances are also of some use in counteracting the progressive deformity, and rendering life more tolerable to the patient, when bedridden.

FRAGILITAS OSSIUM.—Brittleness of the bones is, pathologically, the opposite condition to Rickets; implying a superabundance of earthy matter in their composition. The only specimen with which I am acquainted, is an upper end of the Femur in the Museum of St. George's Hospital.

Occurring as a natural change in the bones as life advances, it may also, at other periods, be symptomatic of cancer, syphilis, scurvy; and, probably, of other diseases of, or affecting, the osseous system.

TUMOURS OF BONE.

EXOSTOSIS.—*Structural Conditions.*—Exostosis is an out-growth of bone; its texture therefore resembles either the compact or the cancellated structure of bone.

The *compact* variety, consisting of solid bone, is of small size, and is very hard—hence named *ivory* exostosis. It is generally situated on the flat bones, especially the cranium; occasionally on the scapula, ilium, or the great toe, from the ungual phalanx of which I have removed such an out-growth. This variety of exostosis, observes Sir James Paget, occurs in two forms. Some grow on the exterior of the bones of the skull, in smooth, spheroidal, or lens-shaped lumps, attached, commonly, by rather narrow bases. Others, which are usually of deeply lobed and nodular shapes, grow in the diploe, or the frontal or other sinuses, whence, as they enlarge, they project through the gradually thinned and perforated layers of bones that at first enclosed them. The former kind rarely increase to an inch in diameter; the latter may increase to many inches, and they commonly project into the cavity of the skull, as well as externally, or into the cavities of the orbits or any other adjacent parts.

FIG. 322.*

The *cancellous* or *spongy* variety, consisting of the open medullary texture of bone, containing marrow, and invested with a very thin layer of compact tissue, is of considerable size, and yields somewhat under pressure. It is generally situated on the shaft of a long bone; particularly the femur, on its inner surface, just above the condyle (Fig. 322); the head of the tibia; or phalanges of the fingers or toes. Such exostoses are outgrowths from the epiphyscal cartilages, and are thence named by Virchow "enchondrosis ossificans." Another very common situation, according to Mr. Holmes' observations, is beneath the deltoid muscle; but here I have never met with the cancellous variety of exostosis.

In both conditions, the structure of exostosis usually resembles that of the bones on which they severally grow. Thus, the compact variety has a concentric lamellar arrangement, with Haversian canals; the cancellous variety, when continuous with the spongy substance of the epiphysis, is overlaid with a layer of hyaline cartilage, a line or a line and a half in thickness, and this growing in itself and from the periosteum or perichondrium, rapidly becomes ossified towards the centre. Mucous bursæ sometimes form on epiphyseal exostoses: these sacs contain ossifying cartilaginous growths, loose or attached, and communicate with the neighbouring joint,—such bursæ being, according to Rindfleish, prolongations from the articular synovial membrane. Inflammation and suppuration of any such acquired bursa may seriously complicate an exostosis, otherwise quiescent, and lead perhaps to destruction of the joint. Exostosis generally occurs singly; but many may form, when they are usually symmetrical. This is particularly observed in the cancellous variety.

A *third* variety of exostosis is recognized by some pathologists. It is attached to bone, although not as an out-growth, but proceeds from the ossification of tendons, fasciæ, or muscles, and is consequent on chronic inflammation, induced perhaps by injury. Appearing in the form of long, spinous processes of bone, these exostoses may be found in considerable number, and connected with any one or more of the long

* St. Bartholomew's Hosp. Mus., 1, 186.

bones, but affecting chiefly their articular ends at the attachments of tendons. Associated in their nature with this anomalous kind of exostosis are certain ossific formations in the substance of muscles, and which, as arising from some muscular strain or other injury, are known as "exercise-bones." Thus, in the deltoid muscle, osseous development sometimes results from repeated pressure or contusion by the habitual use of a rifle or fowling-piece. Hence, it is occasionally met with in the shoulder of soldiers and sportsmen.

Signs.—The characters of exostosis are sufficiently obvious; a very hard, or a somewhat yielding, rather pedunculated tumour, immovable or nearly so, and attached to the bone as an out-growth.

Causes.—The compact variety is attributed to syphilis, scrofula, or other diseases affecting bone, and which produce an out-growing hypertrophy of the compact osseous texture. The cancellous variety results from the ossification of an enchondromatous or cartilaginous tumour. It may, therefore, be said to be developed through cartilage; while the ivory variety is rarely so produced. Age seems to have some causative relation to exostosis; both varieties commencing, probably, in earliest infancy. The epiphyscal exostosis can only occur in youth, or not later than the twenty-fourth year. (Billroth.) Men are said to be more subject than women to all these exostomatous formations.

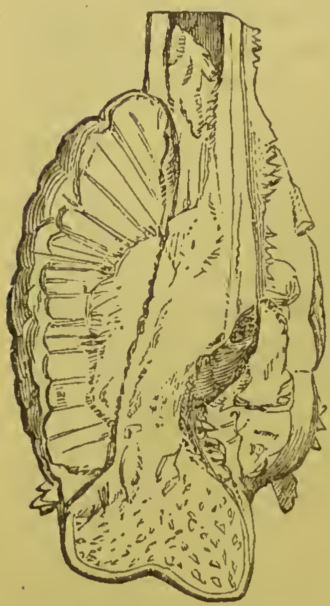
Course and Terminations.—Both forms of exostosis are slow-growing, and particularly the compact variety; but the cancellous attains a far larger size. Both may undergo certain destructive changes; necrosis, or sloughing away from the bone, and with ulceration of the superimposed integument. Both also may occasion various functional disturbances by pressure. The situation of exostosis will very much determine these results. Thus, an ivory exostosis has projected into the orbit; or, growing from the inner table of the skull, has pressed upon the brain; or, from the pubic bone, has perforated the bladder; and cancellous exostosis, or tendinous formations, in the neighbourhood of a joint will more or less impair motion.

Treatment.—Exostoses which remain stationary, or which form in certain situations, as the orbit, or involve a joint, such as the knee, are better left alone. The danger also of exposing cancellated bone should always be considered; diffuse suppuration and pyæmia being very liable to follow the operation of removal. The tendinous formations will probably prohibit operative interference, by their number, and the predisposition to ossific deposits. Otherwise, an exostosis may be removed mechanically, by *excision;* or destroyed, by nitric acid or other strong *caustic*, applied to its exposed base.

Compact or ivory exostosis is often very difficult of excision. Several instruments should be provided; that one failing, another may prove efficient. A trephine, saw, chisel and mallet, or cutting-pliers, are sometimes severally requisite to remove the little ivory-hard lump of bone. They all, in turn, failed in the hands of an expert operator—the late Mr. Keate—although employed perseveringly for nearly two hours. The exostosis having been removed down to its base, caustic may then be applied to destroy the remaining portion by exfoliation. Potassa fusa and nitric acid were thus applied successfully in Mr. Keate's case. Exostoses do not recur after removal; and, fortunately, even when the base of attachment is left, the tumour is not likely to grow again.

Enchondroma.—In connection with bone, enchondroma or cartilaginous tumour has already been considered, as being the most prominent part of the general pathology of this species of Morbid Growth (Ch. II.); for it occurs principally in connection with the osseous system. Enchondroma—or, occasionally, some other kind of growth—may be contained in the centre of a bone, and surrounded by an osseous shell or bony cyst; it is then sometimes designated "bullous exostosis," especially by French Surgical authors.

Fig. 323.*



Treatment.—Excision or amputation will be appropriate, according to the size and relations of the tumour.

Osteo-Sarcoma.—The formation of a *fibrous* tumour in connection with bone is far more rare than the cartilaginous tumour. It is also illustrated by epulis and fibrous nasal polypus; both of which, however, are fibrous *out-growths*. *Periosteal* sarcoma—having its origin in the periosteum—invades the osseous texture, as well as growing outwards. The fibrous tissue, in the form of fasciculi, may have a radiated arrangement from the periosteum outwards. (Fig. 323.) Externally, the tumour has a nodulated character, and its consistence may vary in different parts; being hard and fibrous, or soft and succulent. In the specimen, a portion of the morbid growth has formed also *in* the cancellous tissue of the femur, and occupies the medullary canal.

The *Signs* of any such tumour much resemble those of enchondroma, and their diagnosis is unimportant.

The *Treatment* is excision or amputation.

Cysts.—Two kinds of cysts have been found in bone; the *serous* and *sanguineous*. Their pathology for the most part merges in the general history of these cysts (p. 129). They are *multilocular*, the cavities often communicating; and they are met with in the jaws or in the long bones, their shafts or articular ends. They grow to a large size, that of a cocoa-nut or fœtal head. *Unilocular* cysts are also described by Nélaton as containing solid matter, of a fibrous or fibro-cartilaginous structure, occupying entirely the cavity of the cyst. These are found in the same situations as the last, but grow to a less size. Cysts in bone form mostly in adults.

Signs.—They produce an expansion of the surrounding osseous texture, and at length being enclosed in a thin lamellar capsule of bone, yield a crackling sensation under pressure with the finger and a deeper or more obscure elasticity or semi-fluctuation. Perforation here and there taking place by progressive absorption of the lamellar capsule, the enclosed tumour becomes more clearly perceptible. The superimposed skin yields before the increasing tumour; but without discolouration or any participation in the disease, and there is little or no accompanying pain. The tumour is thus plainly non-malignant in its development.

* St. Thomas's Hosp. Mus., C. 250.

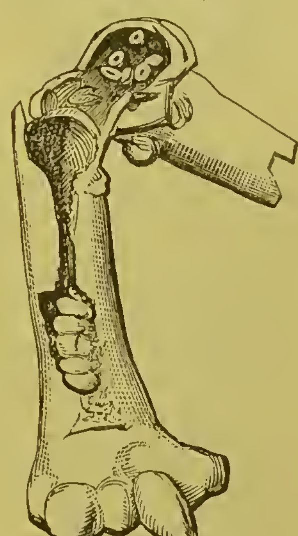
Treatment.—Fluid cysts may be laid open by removing a portion of the bone, by trephining or otherwise, and the cavity dressed from the bottom with lint. Granulation will then obliterate the cyst. *Solid* cysts must be excised, or recourse had to amputation; according to the size and relations of the cyst.

Fig. 324.*

Cystic Tumours.—In bone, as in other parts, tumours occur, containing cysts. Fibro-cystic tumour of bone commences, apparently, in the cancellous tissue, and growing outwards, occasions fracture. The annexed figure represents a section of an enchondroma of the scapula, showing cysts, formed by absorption of the cartilaginous portion in parts, leaving the fibrous stroma. (Fig. 324.) The humerus was extensively involved. (See also "Path. Soc. Trans.," vol. i. p. 344.)

The *Signs* are those of cysts in bone: an elastic sensation or obscure fluctuation. The absence of pain, integumental discolouration, and glandular swelling distinguish this tumour and other innocent cystic tumours from Cancer. The femur was the seat of the disease in four cases, one of which is related by M. J. Adams in the "Path. Soc. Trans.," vol. v., and the remaining three, by Mr. Prescott Hewett, are appended to the report of that case. Amputation was followed by permanent recovery in the above cases.

Fig. 325.†



Hydatid cysts in bone are interesting chiefly in relation to the *fluid* cysts, above described. The entozoon has been, in all cases, the echinococcus or acephalocyst (Fig. 325); except in one case, mentioned by Mr. Stanley, where the cysticercus cellulosæ was found in the interior of one of the phalanges. But hydatid cysts are very rare; eight cases only being referred to in Rokitansky's work; to which a limited number of instances might be added. These cysts may be seated in a flat bone, as the skull or ilium, or in the expanded head of one or more of the long bones.

The *diagnosis* with reference to ordinary fluid cysts can scarcely be drawn. The cysts increasing in size, fracture takes place, as probably the first appreciable sign; and the bone remains ununited. This, however, is incident to other diseases of bone. A discharge of

* St. Thomas's Hosp. Mus., C. 219.

† Ibid. C. 230. Hydatids in bone, the medullary cavity of the humerus being filled with echinococci in various stages of development; their growth has been attended with destruction of the cancellous tissue, and thinning and expansion of the shell of bone,—eccentric atrophy. About the middle of the shaft, this state has resulted in fracture. The patient was a man, aged thirty-four. (Presented by Mr. Boot, of Lincoln.)

fluid containing entozoa would determine any question of diagnosis. This may occur spontaneously, or be obtained by puncture.

The *treatment*, also, is the same as for ordinary fluid cysts; but it will be advisable to destroy the interior of the hydatid cyst by freely applying nitrate of silver or other caustic.

RECURRING TUMOURS OF BONE.—The *Myeloid* form of Enchondroma, in connection with bone, is sufficiently described in the general pathology and treatment of this growth. The characteristic appearances on section are here delineated. (Fig. 326.)

FIG. 326.*

Recurring *osteoid* tumour is illustrated by a series of three preparations in the Museum of the Royal College of Surgeons, to the remarkable history of which Mr. Holmes has called attention. A hard and heavy, dry osseous substance formed around the ends of the femur and tibia, projecting into the knee-joint, extending far up the thigh and implicating the popliteal artery, vein, and nerve, so as to cause œdema and severe pain. (Prep. No. 3244.) Amputation was performed at the thigh. The patient remained well for five years; then another osteoid tumour formed on the stump of the femur, accompanied with severe pain. Amputation was performed higher up. The tumour appeared to grow, not from the bone itself so much as from the periosteum, and enclosed the femoral artery. (Prep. No. 3245.) An interval of health again continued for two years; when another tumour formed about the stump, progressed upwards, out of reach of operation, and finally proved fatal, by inflammation and sloughing of its soft coverings, twenty-five years after the first appearance of the disease. The general health of the patient, a male, remained unaffected during the whole period. (Prep. No. 3245A.) Another, and very similar case, may be found in Paget's "Surgical Pathology."

These cases of recurring osteoid tumours certainly bear a remarkable analogy, in their course and tendency, to the recurring fibroid and fibro-nucleated tumours—varieties of fibrous tumour.

CANCER.—Each species of Cancer—*encephaloid*, *scirrhous*, *colloid*, and *epithelial* cancer—is liable to form in connection with bone; but encephaloid is the most frequent. Like other diseases of bone, Cancer may affect the *substance* or the *surface* of a bone: in the one situation, it is known as interstitial or possibly central cancer; in the other, as periosteal cancer.

In the *substance* of bone, *interstitial* cancer occurs in the form of scattered nodules, having a whitish colour, and the consistence of scirrhous, or hard encephaloid cancer. The cancer-cell—so little absolutely characteristic of cancer—may be indistinguishable or absent. These nodules coalescing, form a mass, which occupies the cancellous tissue, and extends into the medullary canal. The bone surrounding

* St. Bartholomew's Hosp. Mus., 1, 12.

such a formation is expanded and thinned or thickened; with osseous fibres traversing the substance of the tumour, radiating from its centre. It is situated most commonly in the articular ends of a long bone, or in a flat bone, as the pelvis or skull. As affecting the whole bone, this condition of the disease is sometimes designated *infiltrated* cancer of bone.

Fig. 327.*

On the *surface* of bone, *periosteal* cancer forms between the bone and periosteum; rarely involving the one, while the other may sometimes be traced over the tumour. Osseous fibres radiate from the surface of the bone through the tumour; and a bony deposit, forming a coral-like mass, often spreads around it. Periosteal cancer appears, usually, in the long bones, especially affecting their articular ends. (Fig. 327.) The incrusting cartilage of the contiguous joint generally escapes, in both this and the interstitial formation of cancer; although the disease may extend to the capsule.

Osteoid cancer is a term used to designate a further degree of ossification than that commonly met with in interstitial and periosteal cancer-growths. This is analogous to the ossification of enchondromatous or cartilaginous, and fibrous, tumours. Osteoid cancer is described by Mr. C. H. Moore as being, in a well-marked case of the primary tumour, a large mass of the hardest enamel or ivory-like bone; the glandular disease is bony, though it may be less hard; and the disease disseminated in the soft internal organs, and protruding into the blood-vessels, is also in great part osseous. The osseous fabric or skeleton of any tumour which has undergone ossification, may thus represent an *osteoid* tumour or growth; as well as when such a tumour appears in the form of a purely osseous growth or out-growth, *e.g.*, exostosis. The characteristic appearances of the new bony-growth are seen when the soft growth, with which it is associated in the general mass of the tumour, is removed by maceration. I have here represented the skeleton of an ossified encephaloid cancer, as an osteoid tumour. (Fig. 328.) The section of a femur, showing the osseous part of such a tumour, which occupied the place of the shaft of the bone.) The osseous substance is cancellous and spiculated; but the form of the cancellous spaces differs from those of healthy bone. The whole tumour measured thirty-six inches in circumference. It was taken from a girl aged eleven years.

Fig. 328.†

Any bone is liable to cancer-formation; but some are far more so than others. The femur and tibia are most subject to the disease, and particularly the articular ends of these bones at the knee-joint. Thus, of 20 cases of cancer of the long bones of the lower limb, 11

* St. Bartholomew's Hosp. Mus., 1, 27.

† Ibid. 1, 170.

were situated near this joint. The pelvis, spine, skull, especially the antrum, and the humerus, are also seats of cancer.

FIG. 329.*

Signs, and Diagnosis.—(1.) Cancer in the *substance* of bone produces expansion and an osseous tumour; but the nature of this tumour can scarcely be recognized at first. The enclosed encephaloid cancer is much harder than when this disease affects the soft parts. At length, the enclosing shell of bone yields, and the mass declares itself at once, or very shortly, as the tumour, unrestrained, grows more rapidly. The ordinary characters of an encephaloid tumour become apparent: its soft consistence, lobulated contour, and large size (Fig. 329); with purple discolouration of the skin, enlarged, ramifying veins, and pain throughout the course of the disease. Pulsation, of a thrilling or blowing character, may become perceptible, owing to enlargement of the vessels in the tumour, as it undergoes development. Fracture often occurs at the affected part. Glandular swellings and constitutional symptoms will confirm the diagnosis.

(2.) *Periosteal* cancer presents a tumour of more clearly cancerous character, and it grows more rapidly, at an earlier period. The muscles attached to the bone often become extensively infiltrated with cancer-cells.

Thus may Cancer in, or on, bone be recognized and distinguished from any other species of tumour. The diagnosis of malignant and non-malignant tumour of bone lies, however, principally between *encephaloid* cancer and *enchondroma.* Here the presence or absence, ultimately, of the signs which indicate an extension of the disease to the integument and neighbouring lymphatic glands, will mainly determine the question. Puncture with a grooved needle is also available as a critical method of examination, in this case, no less than in other doubtful forms of tumour. I was thus enabled to determine the nature of a tumour at the lower end of the femur, close to the knee-joint, which in point of consistence and lobulated appearance much resembled enchondroma. Amputation was performed, and the mass proved to be encephaloid.

Pulsating encephaloid may be distinguished from *aneurism* by the expansive, heaving character of the latter, as compared with the thrilling vibration of the former.

Treatment.—*Excision* will be appropriate only in cases of limited cancer-growth in, or on, bone, and when situated where the whole diseased portion can thus be removed. But under, apparently, the most favourable circumstances, the operation itself may prove most *perilous.* I once assisted my colleague, Mr. De Meric, in removing an apparently movable tumour, the size of a small orange, and situated over one of the mid-ribs. But this little mass sprang from the bone, the rib readily broke, and the welling up of blood from the tumour—an encephaloid cancer—was so profuse, that the patient nearly died on the spot. He sank in a few days from hæmorrhage into the pleura.

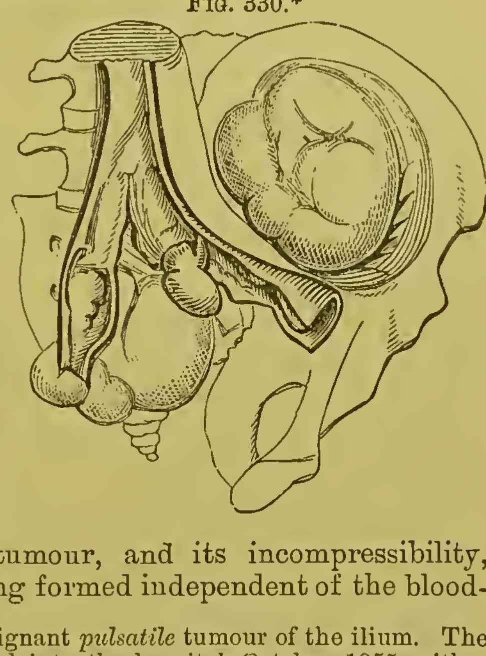
Amputation must generally be resorted to. This operation should

* "Trans. Path. Soc. Lond.," vol. xxii. Mr. H. Arnott's case.

be performed in the earliest recognized condition of the disease, and certainly before any enlargement of the lymphatic glands has evinced the supervention of systemic infection. Moreover, removal by amputation can only be effectual for the prevention of the recurrence of cancer, when the operation is performed high above the part affected, so as to be entirely free of the seat of the disease. Hence, in *interstitial* cancer of bone, the line of amputation should be, not in the continuity of the bone, but above the next joint; and in *periosteal* cancer the line will be most judiciously selected even higher up, above the origin of the muscles infiltrated probably by proximity to the disease.

PULSATILE TUMOUR of Bone, and OSTEO-ANEURISM.—*Structural Conditions.*—A pulsating tumour in, or on, bone may be—(1) a tumour, *not itself* pulsating, but in connection with an artery which communicates its pulsations thereto; as an enchondromatous, fibrous, or other tumour, thus connected; (2) a *vascular* tumour; usually cancerous and, particularly, encephaloid in the course of its development (Fig. 330); (3) a vascular *growth* or erectile tumour of bone, resembling aneurism by anastomosis in the soft parts, and constituting *osteo-aneurism.* This last condition is very rare, if it exist at all; the best authorities, such as Cruveilhier and Rokitansky, are agreed respecting the rarity of osteo-aneurism, and that most pulsating tumours of bone are highly vascular encephaloid tumours.

FIG. 330.*



The situation of any such tumour is generally the *cancellous interior* of a bone, especially of the long bones, at their articular ends; as the femur, tibia, humerus, radius; also in the flat bones, as those of the pelvis and skull, and in the ribs.

Signs, and Diagnosis.—An enlargement of the bone, with a thrilling pulsation and bruit, are symptoms common alike to a highly vascular tumour, such as advanced encephaloid cancer, or aneurism by anastomosis. And this pulsation subsides on compressing the main artery of the limb. But the persistence of a tumour, and its incompressibility, would be distinctive of a mass having formed independent of the blood-

* St. George's Hospital, II. 231. Malignant *pulsatile* tumour of the ilium. The patient, a man aged fifty-one, was admitted into the hospital, October, 1855, with a small tumour in the neighbourhood near the sacro-sciatic foramen, pulsating very distinctly. This disease was referred to an accident eight months previously. The case was distinguished from aneurism of the gluteal artery—a very rare condition—by the different character of the pulsation, by the fact also that pressure in the sacro-sciatic notch did not control the pulsation, and by the absence of bruit. In November, 1856, the tumour had increased very much on the nates, and presented also in the iliac fossa, where fulness and pulsation were perceptible on deep pressure. The growth had now acquired a lobulated form, its consistence varied in different parts, and the softest parts of the mass were most pulsatile. There was paralysis of the sphincters of the bladder and anus, and occasional hæmaturia. The patient was emaciated. Œdema of the lower extremities, especially of the left, supervened; and death ensued in about two years from the commencement of the

vessels, a vascular *tumour*, and not a vascular *growth* or enlarged congeries of vessels. The bony case, however, which encloses any such tumour renders this test inapplicable, until the bone yields and the mass protrudes on the surface of the bone. Or compression of a main artery may be impracticable, owing to the situation of the tumour, as in the pelvic bones. Or again, the supply of blood may come from so many arterial branches, that it cannot be arrested by compression. A tumour pulsating in *connection with an artery* is also distinguished in like manner.

Subsequently, the nature of the tumour will be still further declared by its more developed characters; encephaloid cancer, for example, enlarges rapidly, and involves the skin and lymphatic glands.

Treatment.—Having due regard to the almost exclusive cancerous nature of pulsating tumour of bone, *excision* must have the same restricted applicability as with regard to cancer of bone in general. This operation has failed in cases of cranial and scapular pulsating tumours.

Amputation is the only justifiable operation of removal, in other than the few exceptional cases alluded to. The more decidedly encephaloid the disease, the more appropriate will be this more sweeping operation. It should be performed as soon as the nature of the disease is declared, and the line of amputation be chosen above the joint nearest to the bone affected.

Ligature of the *main artery* leading to the part is said to have proved successful in some cases; but probably not in pulsating tumour of bone having an encephaloid character. Compression might be tried previous to ligature.

Diseases of Particular Bones.—Cranial Bones.—*Caries* and *Necrosis* of these bones are liable to occur, as one of the local manifestations of Scrofula or of Syphilis. Commonly affecting the arch of the skull, and particularly the frontal bone, the ethmoid and sphenoid bones do not escape. The temporal bone seems specially prone to scrofulous caries.

The *structural condition* and *signs* are both described under the general pathology of Caries as affecting the *surface* of Bone, and of Scrofulous and Syphilitic Ostitis, and *exfoliation.*

The *causes*, most frequently constitutional, are sometimes traumatic; as exfoliation resulting from a contused wound of the scalp, or other injuries of the head.

The *course* of either state of disease is important with reference to the probability of cerebral complications; meningitis with effusion, convulsions and coma, being apt to supervene and terminate fatally. Caries of the petrous portion of the temporal bone, as a form of Scrofulous disease, is more particularly dangerous. Earache with chronic suppuration leads to perforation of the tympanum; the ossicula

disease. Post-mortem examination disclosed further particulars. A very large mass of "malignant disease" was found connected with both surfaces of the iliac bone, and section on the dorsal aspect showed a *cavernous* structure. The arteries communicating with these large spaces accounted for the pulsatile character of the tumour. Both the ilium and sacrum were extensively eroded, the sacro-iliac joint destroyed, and spicula of bone were found scattered about the substance of the growth. The two portions of this mass, on the opposite sides of the iliac bone, were continuous through the substance of the bone, and around the sacro-sciatic notch. In the course of the disease, the internal iliac and other veins had become infiltrated with malignant deposits, which had also taken place in the left kidney.

crumble, loosen, and are washed out by a profuse fœtid discharge, exposing the dura mater continuous with the cavities of the ear. If the disease be not fatal, permanent deafness results.

Treatment.—The local measures for the removal of carious or necrosed portions of bone by operative interference, and the constitutional treatment of Scrofula or Syphilis, are in no way peculiar to the Cranial Bones.

Other Bones are less frequently liable to caries and necrosis: the *sternum*, *ribs*, *scapula*, and *pelvic* bones. The pathology and treatment, in such cases, present no essential peculiarities.

DISEASES OF THE JAWS will be considered, under this title, in connection with Diseases pertaining to the HEAD.

DISEASES OF THE SPINE.—See SPINE.

JOINTS.

CHAPTER XXXIV.

INJURIES.—SPRAINS.—WOUNDS.—DISLOCATIONS.

SPRAINS OR STRAINS OF THE LIGAMENTS OF JOINTS.—These lesions essentially resemble similar injury of TENDONS (Ch. XXII.). The *ankle* or *wrist-joint* is most commonly affected. Severe pain, possibly inducing syncope, is soon followed by swelling around the joint; succeeded by stiffness, and continued inability to use the joint. A very severe sprain, or its repetition, may leave the joint in a state of permanent weakness, and liability to dislocation. Or disease of the joint may ensue, in persons predisposed by any constitutional condition, as a rheumatic or gouty diathesis. And it would seem that injury to a joint so alters its structural condition as possibly to induce disease under favourable circumstances; and perhaps after the lapse of a considerable period. Thus, Sir B. Brodie, shortly before his death, I believe, suffered from a malignant tumour of the shoulder, which was, apparently, referable to some textural disorganization consequent on dislocation of the joint some years previously.

The *cause* of sprain is a violent and sudden twist or wrench of a joint, whereby the opposing ligaments are stretched or somewhat ruptured. Even the epiphyses of bone may thus be detached, in a young subject.

The *treatment* consists in an easy position and rest; warm or cold applications, according to the inflammatory character of the swelling and the feelings of the patient; followed by stimulating embrocations, and the support of a bandage, strapping with broad strips of plaster, or a starched bandage.

WOUNDS OF JOINTS.—A wound extending into a joint may, like other Wounds, be *incised*, *punctured*, *contused*, or *lacerated;* and the joint, accordingly, is more or less opened, or extensively injured. But the

admission of air into the joint chiefly determines the importance of any such lesion; and thus the pathological condition of these different wounds must be estimated by this consideration. The extent of the synovial membrane or the size of the joint should also be taken into account.

Signs and Symptoms.—The escape of synovia from the external aperture, or an exposure of the interior of the articulation, are the only pathognomonic or absolute signs of a wound into a joint. Synovial fluid is recognized by its translucent, viscid, albuminous character, resembling raw white of egg; the interior of a joint presents the additional characters of glistening synovial membrane and cartilage, and the peculiar disposition of the articular surfaces. But these appearances should be discovered by inspection, or gentle introduction of the finger; an exploring instrument might penetrate the synovial membrane, and cause a wound not otherwise existing. Wound of an adjoining bursa would be attended with the discharge of a similar fluid, but examination of the interior will determine the diagnosis.

Inflammation of the synovial capsule rapidly supervenes, presenting the usual appearance of synovitis, but distinguished by two peculiarities: the *intense* pain, and *more acute* constitutional disturbance. Suppuration also is almost inevitable, with hectic, and irreparable destruction of the articular surfaces constituting the joint; or pyæmia intervening at an early period, proves fatal. In two cases under my care in the Hospital, wounds of the knee-joint exposing the articulation, both terminated in this way.

Treatment.—Preservation of the limb—without any operative interference—should always be attempted, in the first instance. But the probability of success will depend chiefly on the nature of the wound, and the extent of the synovial membrane or the size of the joint. A small incised wound or puncture, in a small joint, as one of the finger-joints, allows of preservation with great probability of success; a large, open, and perhaps contused wound, in a large joint, as the knee, is almost surely fatal to limb and life. Among large joints, however, those of the upper extremity—the shoulder, elbow, and wrist—are, commonly, more favourably disposed than in the lower extremity—the hip, knee, and ankle. To save a joint, the wound must be at once closed, in order to solicit union by primary adhesion. For the closure of a small cut or puncture, collodion may be an efficient application; for a larger wound, a pledget of lint or piece of isinglass adhesive plaster should be used; or I would try the dressing with carbolic acid paste on tinfoil, according to Mr. Lister's plan under similar circumstances. Sutures may be inserted, to bring the lips of the wound accurately together before applying any such dressing, but they should be entered only skin deep, not through the synovial membrane; and as matter is more apt to form, under the irritation of sutures, thus preventing primary union, and may perhaps find its way into the joint, I seldom have recourse to them. Cold evaporating lotions, or perhaps a few leeches, will aid in repressing inflammation. But the limb must be kept in a state of absolute rest by means of a splint, and in such position, therefore, as shall be most conducive to relaxation and ease. I thus succeeded in saving a knee-joint, which had been opened by the kick of a horse, and with no anchylosis resulting.

Synovitis having proceeded to suppuration—the synovial capsule

having become converted into an abscess, the joint should be laid freely open by incisions, as advocated by Mr. Gay; and a position of the limb secured favourable for its utility, in the event of irreparable destruction of the articulation, followed by anchylosis.

Destruction of the joint without this issue must be met either by *excision* of the diseased bone, or by *amputation* of the limb. The choice of these alternatives should be determined by a due consideration of the local and constitutional conditions. Fortunately, *traumatic* arthritis, as proceeding from the synovial membrane to the adjoining cartilages and bones, seldom engages these structures beyond the range of excision. But the constitutional exhaustion may be so severe, as to compel recourse to amputation, rather than peril life by the slow recovery consequent on excision. Or, amputation may become necessary—and then without an alternative—*after* excision.

Primary amputation, it would thus appear, should not be resorted to in any case. But, in its preventive relation to pyæmia, more especially, it is questionable whether this operation might not be justifiable occasionally. An open, and perhaps *contused*, wound of a *large* joint, as the knee, represents conditions which may justify immediate amputation. In the two such knee-joint cases under my care, life might perhaps have been saved by at once removing the limb; although in the third such case, both limb and life were preserved without any operative interference.

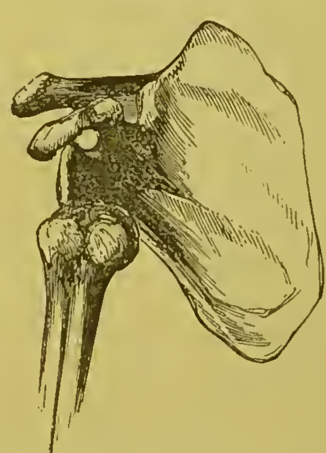
Fracture involving the joint, or dislocation, as complications, in similar cases of wound, mostly demand immediate amputation.

Wounds of Particular Joints are to be regarded in accordance with the general pathology and treatment of this kind of injury.

Dislocation.

Dislocation.—*Structural Conditions.*—Dislocation is a displacement of the articulatory portion of a bone from the surface on which it was naturally received; accompanied by more or less laceration of the ligaments, of the tendons and muscles, or other surrounding structures, and with some effusion of blood around the seat of injury. As arising from external violence, Dislocations may be termed *traumatic;* and when consequent on destruction of the joint from disease, they are named *spontaneous* or *pathological* — dislocations which take place chiefly in the hip and knee-joints. Dislocations differ essentially in regard to the mode of their reparation, according as they are unaccompanied or attended by an open wound communicating with the dislocation; the one being termed *Simple*, the other *Compound*. *Complicated* Dislocation is also a recognized distinction, signifying the concurrent injury of some other part. But this is not an essential condition, as pertaining to Dislocation. *Congenital* Dislocation arises from malformation of the joint affected. In respect to the extent of displacement; dislocation may be *incomplete*, as hinge-joint dislocations not unfrequently are; or *complete*, as those of orbicular joints usually are (Fig. 331); this

Fig. 331.



difference being due to the particular shape of the articular surfaces. The primary displacement is made more complete, especially in orbicular-joint dislocations, by tonic contraction of the muscles subsequently.

Signs.—Dislocation is attended with a corresponding defacement or deformity of the *outline of the joint;* as represented by dislocation of the shoulder-joint, downwards into the axilla. The natural prominences of bone near the articulation either disappear, or are less conspicuous, as the great trochanter at the hip-joint; or they may be more prominent, as the acromion, in dislocations of the shoulder. The *length of the limb* is altered, and especially if the dislocation be complete. Elongation, or shortening, is produced; according as the head of the displacement bone happens to be lodged below, or above, the level of the articular surface on which it naturally moves. The possibility of either, or of only the latter, alteration of length taking place is determined by the form of the articulation. An orbicular joint allows of dislocation in any direction from its circumference; upwards, downwards, forwards, backwards. Hinge joints cannot allow of displacement in more than three directions; backwards, forwards, and laterally, to the right or left. The *direction* of the dislocated bone, and thence *of the limb* below, is characteristic. Certain muscles being thrown out of action, by displacement of the portion of bone to which they are attached; others, thus acquiring a mechanical advantage, preponderate. The natural balance of opposing muscles, as flexors and extensors, is lost, and the limb acquires that particular attitude to which the predominant muscles direct it. To these positive signs may be added two negative ones: *immobility* of the limb, which gradually supervenes, in proportion to the tonic contraction of the muscles; and also the *absence of crepitation.* A false crepitation can sometimes be felt, owing to friction of the articular head of the bone on the torn ligaments and tendons; unlike the rough attrition of the bone-ends in fracture. The extravasation of blood gives rise to the appearance of ecchymosis or bruise, as the blood becomes subcutaneous; but this may not take place for some days after the dislocation. Bruising will, of course, be more immediate and conspicuous where dislocation is produced by direct violence to the part, as by a fall on the shoulder. In examining a dislocation, the limb should be compared with its fellow; at least, in any doubtful case. Pain and inability to use the limb are *functional* symtoms of Dislocation, but of equivocal value in aid of determining the nature of the injury.

Diagnosis.—The pain may be insignificant at first, before swelling supervenes; and in oft-recurring dislocation, where the ligaments and muscles are weakened, especially in an old feeble subject. The power of motion may be retained under similar circumstances, for the tonic contraction of the muscles is insufficient to fix the limb. But if both pain and powerlessness are present, they may each rise from other causes than dislocation; from fracture, sprain, a bruise, or rheumatism. The *physical* signs of Dislocation are each, in various degrees, invariably present, and are almost exclusively connected with Dislocation.

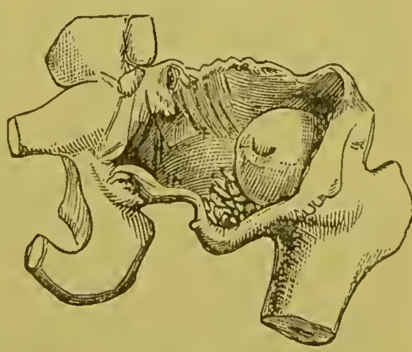
It is only as compared with Fracture in the neighbourhood of a joint that Dislocation can be confounded. But, firstly, the outline of the joint is different, otherwise than in exceptional cases. Thus, dislocations of the hip-joint may be distinguished from fracture of the neck of the thigh-bone, by this sign; so also, dislocations of the

shoulder-joint, as compared with fracture of the anatomical neck of the humerus. When fracture exists, the reduction of displacement by extension of the limb, and the immediate return of displacement on leaving the limb to itself, will best distinguish this injury from dislocation, as a general rule. But dislocation may co-exist with fracture near the joint, as rare forms of double injury; principally in the shoulder, wrist, and hip. Then, again, as to alteration of the length of the limb; elongation is always peculiar to dislocation; shortening may, however, be due to unimpacted fracture with displacement. Fracture may, thus far, simulate dislocation upwards, in orbicular dislocations; or dislocation, forwards or backwards, in hinge-joint dislocations. But it is only in such directions of displacement that shortening of the limb can be equivocal. The direction or attitude of the limb is almost always peculiar to dislocation. Lastly, the crepitation and mobility of fracture are both absent with dislocation. Tonic muscular contraction, whereby an articular displacement becomes fixed, proceeds slowly; and immobility, therefore, can scarcely be regarded as an early sign of dislocation. In one case, a dislocation of the femur into the foramen ovale was examined by Sir A. Cooper, a few minutes after the accident; the limb was still very movable, and continued so for the space of nearly three hours, when it became fixed. Paralysis may be attended with such muscular relaxation as to allow of free movement, in examining a limb with dislocation.

But if the physical signs of Dislocation, taken severally, are thus insufficient; *collectively*, they cannot fail to establish the diagnosis of this injury.

Causes, and Effects of Dislocation.—Dislocation is produced, in general, by external force, suddenly applied. *Predisposing* causes are, however, very influential. Some such cases are functional actions depending on anatomical conditions; as the shape of the articular surfaces allowing a free range of motion, laxity of the ligaments retaining them, and the powerful action of many muscles on a long lever-like bone. All these predisposing conditions are combined in the shoulder-joint, and less so in the hip. Hinge joints, being more favourably circumstanced anatomically, are less liable to dislocation. Other predisposing conditions are acquired by disease; and these also have reference to the cartilage and head of the bone, which may be destroyed by ulceration and caries; to the ligaments, as loosened by this process (Fig. 332); or to those muscles which naturally aid in retaining the articular surfaces in apposition, but which may have become wasted and enfeebled, or paralyzed.

Fig. 332.*



Dislocation is attended with more or less shock, followed by reaction; or the latter is sometimes accompanied with exhaustion, this

* St. Bartholomew's Hosp. Mus., 3, 24. Elongation of capsule of hip-joint, to the extent of from four to five inches, with a tuft of filiform processes. Cavity of the acetabulum nearly obliterated. Head of the femur partially absorbed, and the round ligament has disappeared. See also "Mod. Chir. Trans.," vol. xxiv.

mixed state constituting traumatic delirium or prostration with excitement; which may be succeeded by tetanus. But, in general, no such serious consequences need be apprehended; after the dislocation has been reduced, the immediate shock of the previous injury soon passes off.

Reparation.—The ruptured ligaments, and tendons, if any be torn, are disposed to re-unite by primary adhesion, without inflammation. Lymph is effused which speedily passes into fibrous tissue, through the medium of nucleated blastema. Any superfluous reparative material, and the blood extravasated by the injury, are absorbed; and thus the concomitant swelling subsides. The joint is ultimately restored to nearly its originally perfect construction. This presupposes the previous *reduction* of the dislocation.

If the bone remain dislodged from its natural articulatory surface or cavity, then a *new joint* is constructed, the formation of which will be described in connection with Unreduced Dislocation.

The *Prognosis* of reduced Dislocation is favourable, with regard to re-union of the ruptured ligaments and the tendons, if any be torn; their reparation by adhesion being subcutaneous, and not affected by exposure to the air, as in the healing of an open wound.

But the prognosis must be determined by a due consideration of all those internal causes which either aid the recurrence, or may prevent the original reduction, of Dislocation; and which are, moreover, *persistent* in their tendency to perpetuate the displacement.

Causes of *recurrence* may be noticed first, they being among the conditions already mentioned as predisposing to Dislocation. Some of these conditions are, as we have seen, anatomical; a patulous shape of the articular surfaces, laxity of the ligaments, and a long lever-like bone, on which many muscles act. Hence dislocations of the shoulder-joint are specially apt to recur, and less so hip-joint dislocations. Hinge joints are, anatomically, less disposed to re-dislocation. Other such causes are morbid conditions; ulceration of the articular cartilages, with perhaps caries of the adjoining bone, relaxation of the ligaments, a weakened or paralytic condition of the muscles. Of causes *opposing* reduction, may be mentioned the anatomical shape of the articular surfaces; as the prominent rim of the acetabulum, in hip-joint dislocations, and the cup-shaped head of the radius, which is locked in front of the humerus, in dislocation of that bone forwards. Any ligaments which may not have yielded with dislocation, seem to bind down the bone; as the first phalangeal bone of the thumb when dislocated upon its metacarpal bone. Tonic contraction of the muscles can scarcely be regarded as an unconquerable source of opposition; but the structural change of the muscles which accompanies their permanent shortening and functional adaptation, in unreduced dislocation, is a condition of resistance, not to be overcome judiciously by forcible reduction; and less so in proportion to the duration of this condition. The prognosis is that of *unreduced* dislocation, with the formation of a new or substitute joint.

Treatment.—After Dislocation, especially of the orbicular joints, the muscles which favour the particular displacement draw the head of bone into its new position, and there fix it; but this displacement, and fixation, are accomplished *gradually.* The head of the humerus, for example, having been displaced forwards by the violence which

caused dislocation, it is then drawn inwards, and eventually there fixed. But, *immediately* after Dislocation, the muscles are always partially paralyzed by the shock to the nervous system consequent on the injury, and for a short period they remain powerless. Subsequently, their tonic contraction comes into operation. Therefore, at the time of dislocation, and soon after, the displacement caused by muscular action can be easily replaced; and any resistance of this kind may be *partly* neutralized by a position suitable to the further relaxation of the antagonistic muscles. This, then, is the earliest condition of dislocation, ere the muscles *complete* the displacement; and this the most favourable opportunity for its reduction, when the muscles are as yet *powerless.* Thus, immediately after a dislocation of the femur backwards, Liston, having this opportunity, immediately reduced it, on the spot, without pulleys, or even the help of an assistant.

If Dislocation be overlooked or neglected for a few hours, the muscles will then have become more immovably adapted to their new lines of action; subsequently, they become shortened also; a new joint is in process of formation; the track through which the head of bone has passed is occupied with plastic lymph; if the rent in the ligaments be small, this aperture tightly embraces the neck of the displaced bone, which becomes adherent and more fixed; and lastly, the natural articular surface or cavity gradually undergoes obliteration. Replacement is, at length, scarcely practicable, if possible, and certainly not to be accomplished without endangering many structures —muscles, nerves, vessels, and perchance the bone itself; nor without re-opening the track through which the head of bone had passed, and re-rupturing the ligaments; and even then only to find the natural articular cavity effaced or obliterated. Delay, therefore, proportionately precludes replacement by any conservative surgical interference.

The rules of treatment are precisely analogous to those relating to Fracture.

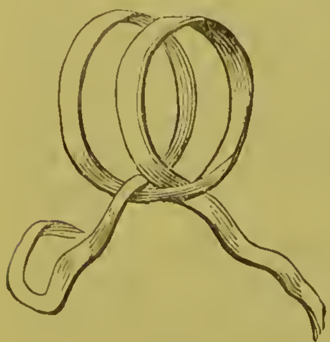
(1.) *Reduction* and *Coaptation*, or replacement of the displaced head of bone in relation to its natural articular surface or cavity. This implies a *suitable position* of the limb, as far as *possible;* to relax the antagonistic muscles which, by their tonic action, retain the head of bone in its new position. But coaptation also implies *extension* and *counter-extension* of the limb, sufficient only to bring the head of bone parallel to its natural articular surface or cavity; the "reduction" of dislocation. Coaptation is then readily effected.

(2) *Maintenance of Coaptation*, during the reparative process of re-union of the torn ligaments, tendons, etc. This still pre-supposes a suitable position; not, however, with the view of relaxing such muscular contraction as maintains coaptation, but for the prevention of re-displacement by the spasmodic action of antagonistic muscles. But it also implies the employment of suitable *retentive appliances;* and *both*, to ensure *rest.*

The *Reduction* of Dislocation is a *process;* in this respect differing from the reduction of Fracture, which is readily effected. In Dislocation, reduction must be accomplished by retracing the displacement which has been caused by the muscles in operation; the head of bone being conducted, through the course it has thus taken, back to the point where muscular action began. Tonic contraction of the muscles

will then effect coaptation. It is in retracing the *course* of displacement—the performance of reduction—no less than as regards the *timeliness* of Surgical intervention, that the guidance of pathology is chiefly experienced in the treatment of Dislocation. To facilitate reduction, muscular resistance is eluded, partly by undertaking reduction as soon as possible after dislocation, when the muscles are as yet inoperative; and partly by placing the limb in a suitable position, as far as possible, to relax the antagonistic muscles. The *semi-flexed* position, as nearly as it can be attained, is the happy medium generally desirable for this purpose. In hip-joint dislocations, flexion of the knee relaxes the three ham-string muscles; while, for dislocations of the knee, the gastrocnemius muscle also is thus relaxed. For shoulder-joint dislocations, flexion of the elbow relaxes the biceps muscle. And it should be remembered that the flexor muscles are always stronger, and therefore more resisting, than the extensors. The resources for subduing muscular resistance will be noticed presently, in speaking of the act of reduction. *Extension* and *counter-extension* of the limb are necessary in all cases, and more especially for the reduction of ball-and-socket dislocations. The extending force may be either manual, as exerted by the Surgeon with an assistant or more; or mechanically applied, by pulleys. Manual extension is less steady and less enduring; and as those who are so employed become fatigued, they relax their exertions, the muscles engaged in the dislocation regain their original supremacy and draw the bone back again to its former abnormal position, reproducing the displacement, and the work of extension has to be done all over again. Extension by means of pulleys is, however, apt to become too forcible, thereby endangering muscles, nerves, vessels, and even the bone itself; but force applied by this means can be better directed than that of personal strength. In like manner, counter-extension may be maintained either by an assistant or more; or by mechanical resistance, a cloth or strap being secured to some fixed point, as a staple firmly fixed in a wall. The relative merits of these two means of counter-extension also should be estimated by the respective characters of the forces, which are thus applied. As a general rule, pulleys are required only to reduce hip-joint dislocations, unless manipulation prove successful. When employed, precautions should be taken that the integuments of the part to which the force is applied are not injured. Extension may, therefore, be applied to the limb through a belt, padded with soft leather. If a strong woollen cloth be used instead, the noose should be fixed around the limb by the *clove-hitch* tie, which retains its hold securely, without tightening. (Fig. 333.) Besides this provision against strangulation, a damp cloth, under the noose, will protect the skin from friction.

Fig. 333.



To what *part* of the limb should extension be applied? On this point, opinions are divided, as with regard to fracture. Some of the most eminent French Surgeons have recommended extension to be made *indirectly*, from the distal extremity of the limb—from the wrist, in shoulder-joint dislocation; from the ankle, in that of the hip-joint. It is alleged that the advantage thereby gained is twofold.

The muscles are not excited to spasmodic action, as they would be were force directly applied to the dislocated bone; and besides this negative advantage, there is also the positive advantage of a longer lever, wherewith to act on the dislodged head of bone. The English School, represented by Pott and Sir A. Cooper in this branch of Surgical Practice, and supported by equally distinguished Continental Surgeons, as J. L. Petit, Duverney, Malgaigne, and Callisen, have advocated extension *directly*, from the dislocated bone. Thus, from the arm, when the humerus is dislocated; from the thigh, when the femur is dislocated. This direct application of extending force avoids endangering the intervening joints, and tells more effectually on the displacement. Certain it is, also, that a long lever is not requisite for any truly surgical purpose. If the muscles be relaxed, no such mechanical advantage can be necessary; if not relaxed, muscular contraction can be so directed as to eventually complete the reduction without the aid of a long lever. Moreover, assuming the obvious advantage of a semi-flexed position of the proximal joint below the dislocation, this position will necessitate the application of any extending force directly to the dislocated bone. Counter-extension is most effectual when applied as directly as possible, namely, from the surface corresponding to the dislocation.

Supposing counter-extension to be rightly adjusted, extension should be made first in that *direction* which the bone has assumed by dislocation. The head of the bone is thereby made to retrace its course, and is finally replaced without any additional laceration of the textures. Then, again, the extending force should be equable, not jerking, and gradually increased; accompanied, of course, by counter-extension, equal, and in the opposite direction.

Any *voluntary* muscular resistance on the part of the patient, during reduction, is subdued by diverting his attention. A question now and then, as to how the accident happened, may answer this purpose, if no other; and by inducing our patient to speak, we overcome any advantage which the muscles attached to the thorax would otherwise have, were the chest fixed, as when the breath is held. This point of practice will obviously be important in reducing dislocation of the shoulder-joint. *Tonic* muscular contraction is most surely overcome by the slow inhalation of chloroform; but this should not be resorted to in the *first* instance. Supposing increasing-extension prove ineffectual, and that any further degree of such force would, or might, endanger the muscles, nerves, or vessels; *then* only, in my opinion, is the administration of *chloroform* justifiable, for then only is the occasional peril of its action warrantable as our next resource. We thus steer clear of two risks: the former concerning the limb; the latter, the life. But if we fail at the time of our first attempt, and followed up with the relaxing aid of chloroform; what then? I omit the objectionable measures formerly resorted to; nauseating doses of tartarized antimony, and the perhaps irrecoverable loss of the vital fluid by copious venesection, in the erect position and from a large orifice to speedily induce cerebral syncope. The *warm bath* may prove sufficiently relaxing; but this failing, we are compelled to accept the only alternative, that of waiting until the immediate consequences of extension have passed off, and then to renew it; aided by the repetition of chloroform, the warm bath, or both these relaxatives, successively.

This *second* occasion, fairly tried, should be our last by increasing-extension; yet it is not our last resource. *Unreduced* dislocations, of some duration, and not reducible by ordinary extension, prolonged even for an hour or two, have sometimes been reduced by *tiring* the antagonistic muscles; simply by attaching a trifling weight to the limb for a few hours. This tiring-extension is quite safe, as regards both limb and life, and would therefore, whenever practicable, be far preferable to increasing-extension under the influence of chloroform; but, if it fails, the muscles will have gained considerable advantage by the further delay, and by the consolidation consequent on inflammatory effusion. While, therefore, tiring-extension might be a valuable *safe-guard*—probably an assistant—in the intervals of a first and second attempt at reduction by increasing-extension, aided, if necessary, by chloroform, as an *extra resource* it is most eligible in old dislocations, where that mode of reduction would be dangerous or useless. The younger Cline, in this way, succeeded in reducing a dislocation of the shoulder which had been out for several weeks and could not be replaced in the ordinary way. Having fixed the shoulder, a brick, attached to the hand, was suspended over the end of the bed. On visiting his patient next day, the bone had returned to the socket.

In the course of extension, and especially towards its completion, it is the practice of some Surgeons to *rotate* the dislocated bone, so as to *forcibly* clear away any adhesions in the path along which the displaced head of bone should return home. But this forcible detrusion of any and every obstacle is damaging and unnecessary. And if such obstacles have become established, in an old unreduced dislocation, then indeed it is very questionable whether reduction should be attempted, and certainly not accompanied with the rupturing force of rotation.

Coaptation, following adequate extension, is the next and final step, after reduction, which it may be said to complete. The displaced head of bone has been reduced, or brought back to that point where the muscles first began to operate, and where it was situated immediately after the displacement as effected by the violence which dislodged the bone. It stands on the brink of its natural articular surface or cavity; the one ready to regain, the other to re-establish, the articulation. This final step it is now the duty of the Surgeon to *observe, or to undertake*, by coaptation—a manipulation analogous to the setting of fracture. Surgical assistance is needed according to the resistance offered by the shape and attitude of the two articular surfaces to be brought together. The head of bone may only need *guiding* to its proper place, into which the muscles, if not too much relaxed, will draw it; or it may require to be *lifted* over the brink of the articular cavity, if this its margin be prominent; as that of the acetabulum, in relation to dislocation of the head of the femur. *Direct* manipulation is, however, more generally necessary in the coaptation of hinge-joint dislocations; while, in ball-and-socket dislocations, the displaced bone is more usually guided into its hole, by properly directing the axis of the limb, towards the finish of extension. The *ligaments* scarcely ever resist. They are, in most cases, extensively torn; the capsular ligaments especially so. But a small rent only, in a ligamentous capsule, may offer some impediment; or the aperture may be occupied by a portion of torn tendon or muscle. Any ligament peculiar to the joint is also generally torn through, as

the round ligament in hip-joint disloeations; but—according to the observations of Sir A. Cooper—if one sueh ligament remain entire, it may oceasion difficulty in the reduction, as he experieneed with respeet to the knee and ankle joints. In dislocations of the latter joint, it is often neeessary to twist the foot, in order to relax the untorn ligament, before reduetion ean be effected. In dislocation of the proximal phalanx of the thumb on the posterior aspeet of the metaearpal bone, it may be necessary to *divide*, subeutaneously, one of the lateral ligaments; the external being most easily reaehed. In all eases, coaptation should be guided by a due knowledge of the pathologieal eonditions, and not effected by mechanical violence.

Coaptation is announced by a snap, a jerk, or sensation of something having given way; this being the signal that the muscles have done their duty by drawing the head of the bone home. If, therefore, the muscular system be paralyzed, as under the influenee of ehloroform, or if the particular muscles engaged be weakened by prolonged extension, or extension be overpowering at the time of eoaptation; in either case, the usual signal cannot be given. But the limb immediately assumes its natural length and attitude, as in repose; and the natural *contour* of the joint is reeovered. The latter sign is the one most available in practiee; for the natural length and shape of the limb cannot be eompared otherwise than by suspending extension, a eessation of effort which would at once undo all that had been gained, if coaptation be not aeeomplished. The natural *mobility* of the limb is immediately regained with coaptation; and this sign, *coupled* with the anatomieal charaeters just mentioned, plainly declares that the natural articulation is restored.

Being thus assured of this event, the Surgeon need do but little more. Muscular contraetion, having finally brought the bone into plaee, retains it there. Unlike fracture, the reduetion of which is aceomplished easily, but maintained only by watchful eare, disloeation is redueed only by watchful care, after which the museles take care of the joint.

To *maintain coaptation*, it is necessary only to fix the limb, and in a suitable position for the relaxation of any museles whieh by their aetion might re-dislocate the bone. This indieation is easily fulfilled by securing the limb with a bandage; the arm to the ehest, the leg to its fellow. Position and immobility are the more requisite on behalf of shallow joints, and if the ligaments be naturally loose; both of which conditions charaeterize the shoulder-joint. The twofold precaution of position and immobility is yet more neeessary on behalf of *any* dislocation, when the muscles whieh usually prevent its recurrenee are themselves naturally flabby and weak, or have been weakened by the dislocation, and by the extension neeessary for its reduetion. If, in sueh case, the limb be not securely fixed and supported in a suitable position, it may re-dislocate itself, not so mueh by the aetion of antagonistic muscles, as by the mere weight of the limb.

Rest of the limb, thus retained in position, will also favour the subsidenee of any inflammation which may have supervened. But, the inflammation being subcutaneous, it terminates in resolution, very rarely in suppuration. Any so-called antiphlogistic treatment, therefore, is as seldom neeessary; certainly not of a eonstitutional character, and loeally only, by the application of a cold lotion in the first instance;

with subsequently friction daily to revive the dormant muscles. Ample time must be allowed for firm re-union of the ligaments or other lacerated textures; failing which, the joint will be permanently weakened and ever liable to re-dislocation. On the other hand, judicious exercise of the joint, by passive motion occasionally, will prevent the tendency, otherwise, to some degree of anchylosis and permanent stiffness; with the irrecoverable loss of muscular power in the limb. Thus, in ten days or a fortnight, the Surgeon may begin to put the joint gradually through its movements; especially the more firmly secured joints, as the hip and elbow; the shoulder-joint, being naturally looser, must be handled more lightly. Some months may elapse ere the patient regains free use of the joint and power in the limb.

COMPOUND DISLOCATION.—*Structural Condition, and Diagnostic Characters.*—Compound Dislocation is, essentially, Dislocation with a wound in the skin communicating; thereby exposing the injured joint, however indirectly, to the action of the air. The structural disorganization, as regards the state of the joint, is the same as in simple discation; but compound dislocation is usually accompanied with more severe contusion or laceration of the surrounding soft textures. This condition, coupled with that of the aperture externally, which is also contused or lacerated, together form a Contused or Lacerated Wound, connected with, and around, a Dislocation.

The *Signs* of this injury are the same as those of simple dislocation, with the additional and distinctive character of an external irregular wound. In short, both the condition and characters are those of simple Dislocation, *plus* those of contused or lacerated Wound.

Compound dislocation occurs most frequently in the ankle-joint, occasionally in the knee and elbow; rarely in the shoulder and wrist; and very rarely in the hip-joint. Of the smaller joints, compound dislocations of the astragalus, and of the thumb, are most common.

Causes, and Effects of Compound Dislocation.—Here also the pathological history is that of simple dislocation, with certain peculiarities superadded. Generally speaking, the dislocated bone having passed through the adjoining soft parts, in the direction of the displacement, and come to the surface, it protrudes through the skin; and thus the wound is an extension of the injury from *within*. But, in some cases, external violence is the cause of the wound in the skin and subjacent soft parts, as well as of the connected dislocation; which may then be regarded as produced by an extension of the injury from *without*. In the one case, the force is applied indirectly, to the bone at some distance off, and the injury is more a laceration, and less extensive; in the other case, the force is applied directly to the joint, and the injury is more a contusion. In both cases, the lacerated or contused textures are damaged beyond the apparent extent of injury; and the shock to the nervous system is more severe than with simple dislocation, owing to the greater damage to the soft parts, including nerves.

Tetanus is, perhaps, more likely to ensue than after a contused or lacerated wound alone, and especially if the compound dislocation be that of a ginglymoid joint, as of the thumb. Injuries of unyielding fibrous or ligamentous textures are generally prone to induce Tetanus.

The textures injured, being in a state of disintegration, die, at least to some extent around, if the wound be allowed to remain open. This purely *traumatic* gangrene is the same as that caused by a

lacerated or contused wound. Limited, therefore, to the part injured, and defined, eventually, by a line of demarcation between the living and dead textures, the gangrene is also immediate, if the injury itself be severe.

Course and Terminations.—Inflammation supervenes, followed by suppuration, often profuse, and partial sloughing; or gangrene, possibly, on a larger scale. Yet this also is limited to the seat of injury. Ultimately, compound dislocation, when reduced, not unfrequently undergoes reparation; the torn ligaments and tendons becoming reconnected, and the wound closing up by the healing process of suppurative granulation and cicatrization.

Spreading gangrene—due to some morbid condition of the blood—is only contingent, occasionally, on compound dislocation; just as it may be associated with compound fracture, and with contused and lacerated wounds. The phenomena of this species of gangrene were described under the last-named form of Injury.

The *Prognosis* of Compound Dislocation, as gathered from the foregoing elements of its natural course and tendency, is far less favourable than that of simple Dislocation. An *open* wound, communicating with the joint, as compared with subcutaneous laceration of the soft parts, is one unfavourable ground of prognostic distinction. Scarcely less so is the *greater extent* of their laceration, usually, in compound Dislocation, especially if produced by direct violence. *Spreading* gangrene is an adventitious condition, but as implying the co-operation of a constitutional cause, it has a most unfavourable significance.

Treatment.—The same rules of treatment are applicable as for simple dislocation; but certain particulars, having reference to the special pathology of compound dislocation, are peculiar to its treatment.

Reduction of the displacement may present special difficulties. Thus, if the bone *protrude*, excision is preferable to violent efforts at reduction. In regard to the ankle, the knee, and elbow joints, removal of the ends of bone may be resorted to, with advantage and safety. The head of the astragalus has been removed, when, by dislocation forwards, it protruded and could not be returned. The practice of excision in compound dislocation, to aid reduction, is as old as the time of Celsus; but in modern Surgery—revived by Mr. Hey, of Leeds, and advocated by Sir A. Cooper—relative to the ankle-joint, it has since been sanctioned, as an occasional expedient, by the united testimony of experienced Surgeons, English, American, and foreign.

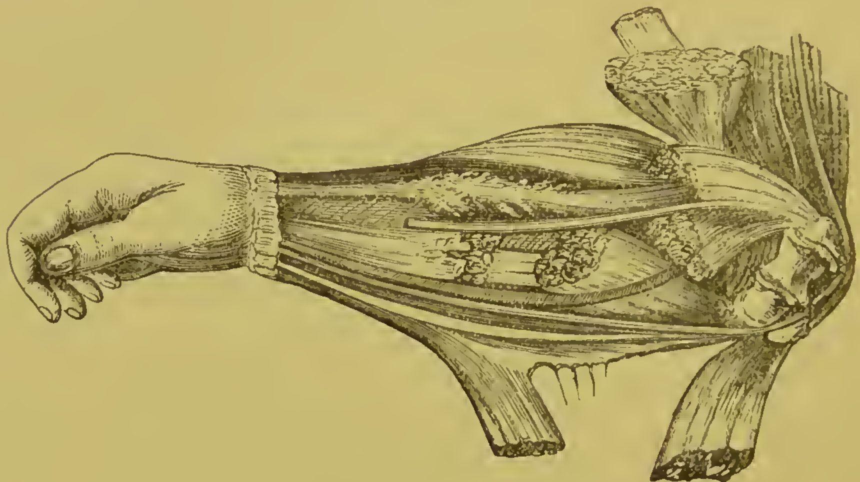
The Wound.—Reduction having been accomplished, and the limb retained in a suitable position—to prevent the recurrence of dislocation—by appropriate bandaging or apparatus, the treatment peculiar to *compound* dislocation is that relating to the wound, and state of the soft parts involved. The *primary* indication is to close the wound, with the view of soliciting its union by adhesion, and thus convert the dislocation into a simple one. For this purpose, a pad of lint—soaked in blood from the wound, as formerly practised, or better, simply wet lint, or soaked in carbolic acid solution—should be applied over and around the wound, so as entirely to exclude the air. But, watching the progress of the case, when primary adhesion becomes obviously impossible, the attempt should be forthwith discontinued, in order to give free vent to matter during the process of suppuration. *Early* solicitation of healing by primary adhesion, and *timely* abandonment of the attempt, in favour

of suppuration, as soon as this event occurs or is inevitable, constitutes a compromise, which overrules any objection as to the *probable* failure of the one and the supervention of the other. It may secure the advantage, otherwise forfeited, of thus having to deal with only a *simple* Dislocation.

In the event of Suppuration, early, free, and dependent *incisions* are indicated, for the same reasons, as in compound fracture; and a poultice, or spongio-piline soaked in warm water as a fomentation, is now the proper application; to be exchanged for light water-dressing, or with carbolic acid solution, when the continuance of warmth with moisture would only sodden and relax, and when the wound is granulating. The same *hygienic* and *medical* treatment also, as for compound fracture, will prove efficacious in sustaining the system under the *hectic fever* and exhaustion consequent on prolonged and perchance profuse suppurative discharge, and in overcoming the typhoidal fever induced by gangrene or sloughing.

Amputation.—The "question of amputation" depending upon the supervention of gangrene, or of profuse suppuration, the *propriety* of this

FIG. 334.*



operation is determined by pathologico-anatomical conditions parallel to those of compound fracture. (1.) *Primary* amputation, only when the whole substance of a limb being involved by compound dislocation, the limb itself is already, in the first instance, virtually lost, and life as inevitably endangered. Such was the condition of compound dislocation represented in Fig. 334, the integuments having been removed from the limb to display the various kinds and extent of lesion. Unique as a new form of elbow-joint dislocation, by dislodgment of the radius and ulna outwards and *upwards* on to the external ridge of the humerus above the condyle, the forearm had thus undergone an "external latero-angular dislocation." The relative position of the bones, and thence the peculiar appearance of the joint externally and configuration of the limb, I have described in the "Brit. and For. Med. Chir. Rev., January," 1866. As justifying amputation, the lesions *co-existing* were these. A large lacerated wound about the middle of the forearm in front, exposing the muscles and a portion of both bones, with

* Royal Free Hospital. (Author.)

the interosseous membrane. All the flexor muscles, superficial and deep, were torn across, partially or entirely, sparing their tendinous and aponeurotic portions, which appeared deep in the wound as so many shreddy strings from which the muscular substance had been raked off. All the vessels and nerves, however, excepting, of course, their muscular branches, had escaped rupture; the ulnar nerve, the inferior profunda artery accompanying it above the joint, and the ulnar artery in the forearm, the median nerve with its interosseous branch and the corresponding branch of artery, and lastly, the radial artery and nerve. But the skin was almost completely detached from the sheath of the muscles on the front and back of the forearm, and some way above the joint. The large tract of subcutaneous cellular texture thus disorganized was infiltrated with blood, not discernible through the skin, which appeared unbruised. A small contused aperture just above and behind the inner condyle communicated directly with the joint, constituting a compound dislocation. This extensive injury was caused by severe contusion and a lacerating wrench between the buffers of two railway carriages. (2.) *Secondary* amputation, when the extent of damage done by the injury being itself partial, the supervention of gangrene or of profuse suppuration is only proportionately probable, and the limb, therefore, not inevitably lost, nor the life perilled. Such postponement of amputation is justifiable to give the limb its chance of preservation by delay; while the preservation of life is provided for by timely amputation, when the adverse circumstances, alluded to, actually supervene.

The rules laid down in surgical works, with reference to the *extent* of injury, are not the expressions of a sufficiently accumulated pathological experience, in different doubtful cases; and they overlook the necessarily unknown capabilities of reparation in different individuals. Cases occurring, from time to time, which have proved exceptional to any such rules, suggest the all-important consideration,—in how many more cases might limbs be saved which are thus sacrificed surgically?

No extent of injury, as to the vessels, nerves, muscles, and integuments—short of the whole substance of a limb being involved—in connection with compound dislocation, can be said to absolutely prohibit the attempt to preserve the limb, in the first instance.

Thus, compound dislocation of the knee-joint was pronounced by Sir A. Cooper to be a condition of disorganization which imperatively demanded primary amputation. Exceptions, occasionally, have since disproved that dictum, in this form of injury. In the case of a boy, nine years of age, at the Westminster Hospital, Mr. White succeeded in saving the limb, by sawing off the condyles of the femur and reducing the bone. In the ankle-joint, the end of the tibia may be removed and reduction accomplished; a proceeding which I remember Mr. Liston advocated more than thirty years ago. A person jumps out of a carriage behind, while the horse is running away, and alighting on his feet, the tibia of either leg may be driven through the integuments, and perhaps come in contact with the earth. Removal of the bruised portion of bone will facilitate the reduction, and has proved successful in preserving the limb. Dislocation of the astragalus, in like manner, may be similarly treated. In two cases of compound dislocation of the foot inwards, one of which was complicated with compound fracture

and dislocation of the astragalus, the parts could be reduced after excision of the external malleolus, and the patients recovered with useful limbs. Both cases occurred in the practice of Mr. Spencer Smith. *Excision*, indeed, bids fair to surpass amputation in other compound Dislocations.

COMPLICATED DISLOCATION.—Dislocation may be complicated by association with the laceration of *muscles* which are put upon the stretch; as the pectineus and adductor brevis, by dislocation of the thigh downwards into the thyroid foramen; even their unyielding *tendons* are sometimes ruptured, as the sub-scapularis tendon, by dislocation into the axilla. *Large blood-vessels* occasionally share the same fate, accompanied with hæmorrhage and livid swelling; a *main nerve* also may be torn asunder. *Fracture* of the shaft, or of the head of the bone dislocated, is another complication. This is more likely to occur in dislocation from direct violence; as by a fall on the hip or shoulder, the neck of either bone is perilled; the olecranon also may be knocked off; the bulky head of the tibia shattered; or the tarsal end of the tibia broken and bruised. Thus, then, all the parts *around* a dislocation are liable to be involved in the injury. But, obviously, none of those special injuries to internal organs can occur, which may complicate the Fracture of certain bones—the pelvic bones, the ribs, the bones forming the skull. Respecting *morbid conditions;* local diseases, *i.e.* of the joints themselves, may predispose to dislocation and thence to its recurrence, by previous disorganization of the joint affected; a parallel kind of complication to that of fracture from disease of the bone. So also, the diseased condition of the joint is frequently a local manifestation of some blood-disease —*e.g.*, syphilis or scrofula, as a constitutional cause, rather than of traumatic or local origin. Whenever dislocation from disease of the joint has the former mode of origin, the reparative process is proportionately slow and uncertain; the more so when the constitutional disease is actually in operation.

Treatment.—Both the general considerations of pathology, and the corresponding Rules of Treatment, pertaining to Complicated Fracture, are applicable also to Complicated Dislocation.

Firstly,—If any *morbid condition* be in operation, locally or constitutionally, predisposing to the occurrence of Dislocation, the treatment must be entirely *subject* to such *causative* condition. Secondly,—If there be any *injury additional* to Dislocation, the treatment of the *dislocation* may be of entirely subordinate importance, even although it be, as in many such cases, severely Compound.

UNREDUCED DISLOCATION and FALSE-JOINT; CONGENITAL DISLOCATION.— These pathological conditions may be taken consecutively: the one as the result of neglected, or possibly irreducible Dislocation; the other as being irreducible or incapable of continued reduction, owing to some congenital malformation. Both are supplementary to the pathology and treatment of ordinary Dislocation.

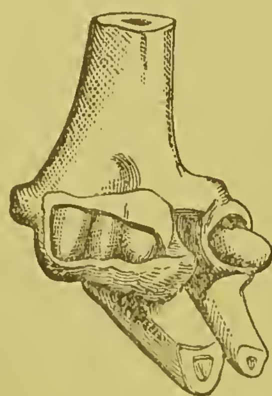
UNREDUCED DISLOCATION and FALSE-JOINT.—*Structional Conditions.*— The alterations of structure consequent on unreduced Dislocation are the formation of a new joint, the obliteration of the former or natural articulation, and of the track through which the head of the dislocated bone passed to its present locality.

The new *joint* is more or less perfectly constructed. If the dis-

placed bone be lodged upon *muscle*, it gradually burrows for itself a convenient nest, the two surfaces become mutually adapted to each other, and a capsular ligament being formed of condensed cellular tissue, an imperfect joint is established. But should the bone have found a resting-place on *bone*, this, by absorption, loses its periosteum, and that its articular cartilage; a receptacle is excavated suitable to

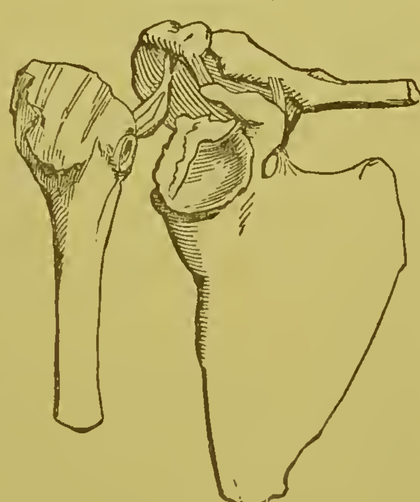
Fig. 335.*

Fig. 336.†



the impression of the displaced articular surface (Fig. 335); a bony rim or lip is thrown up by the periosteum around the margin of this newly formed cavity; the surrounding cellular texture, moreover, becomes condensed into a capsular ligament, which further provides against any displacement; and thus a far more perfect joint is constructed. (Fig. 336.)

Fig. 337.‡



A porcellanous deposit takes the place of cartilage, on the head or surface of the dislocated bone; or instead of this *eburnation* (Fig. 337), an imperfect fibro-serous surface or synovial capsule may be formed. The *natural articular cavity*—whence the bone was dislodged—loses its cartilaginous investment, and closes in. (See Fig. 335.) It is, at length, partially obliterated by a dense fibrous deposit. So also is the *track* in the textures, through which the bone had passed.

Associated with this articular transformation are certain accessory, but somewhat accidental changes, in relation to the ligaments, muscles, and tendons.

* King's Coll. Mus., 1336, 2.

† St. Bartholomew's Hosp. Mus., 3, 33. Old unreduced dislocation of elbow-joint, backwards; with a new capsule embracing the articular end of the humerus; there are also new capsules, for the articular surface of the ulna, and for the head of the radius.

‡ Ibid. C. 34.

The *ligaments* perhaps become firmly adherent to the neck of the bone, thus further opposing its reduction, and if the rent be small through which the bone escaped, it may be tightly embraced. This is more apt to occur in a capsular ligament. Other ligamentous conditions are peculiar. The orbicular ligament around the neck of the radius may have been carried away entirely by dislocation of this bone, and be firmly attached at both ends to the humerus. A specimen of this kind is preserved in the Museum of St. George's Hospital. The *muscles* which act on the displaced bone become permanently shortened, while their lines of action get accommodated to the displacement, and help to retain the bone in its new position. Or if any tendons were partially or entirely torn across by the violence of dislocation, they may have acquired new attachments, and such as are mechanically unadapted to the action of the muscles. A ruptured tendon sometimes forms a band of adhesion between the bones. In one instance, the tendon of the brachialis anticus muscle having been torn off the coronoid process of the ulna, which was dislocated backwards into the olecranon fossa, this tendon became firmly united both to the trochlear surface of the humerus and to the ulna below its original attachment, forming a kind of soft anchylosis between them. A tendon having its attachment thus displaced, is unfavourable to the action of the muscle connected therewith, yet its new attachment may aid in rendering the dislocation irreducible. Bony nodules form, occasionally, in the tendons around the seat of dislocation. Lastly, in these general changes, should be noticed the important one of adhesion sometimes having taken place between a large artery and the capsule or periosteum of the displaced bone.

All these structural alterations take place very slowly. The destructive changes implying an irreparable sacrifice of the articular cavity, Nature reluctantly obliterates it, and with it the opportunity for reduction, only when long disappointed by delay and wearied by the lapse of time. Even after a period of thirteen years, in dislocation of the hip-joint, the acetabulum may still retain its form and depth and cartilage; as shown by a specimen which Fournier has recorded. The reparative alterations—those pertaining to the formation of a new joint—are most complete in ball-and-socket dislocations, as the hip-joint; the compensatory substitute for any hinge joint is far less complete. In some such instances even, bony anchylosis is the result.

The *Diagnostic Signs* of unreduced Dislocation, and of the construction of a new joint, are—the physical signs of dislocation, *coupled* with restoration, more or less entirely, of the functional use of the limb or part. The characteristic alterations in the form of the joint, length of the limb, and direction of its axis, still remain; while the power of using it is regained, and proportionately as the new articulation is perfectly finished off. Hence, this restoration of function is, at length, far more thoroughly established in unreduced Dislocation of a ball-and-socket joint, than in that of a hinge joint.

Treatment.—The question of *interference* should be determined by the *mobility* of the new joint. (*a*) When freely movable, the natural articular cavity or surface is probably obliterated, the processes of construction and destruction having proceeded equally. Hence, the indication is, *not* to interfere—to leave such an unreduced dislocation

alone; any attempt at reduction being useless or worse. Under these circumstances, reduction has, indeed, been effected, but with great injury to the limb, and even with a fatal result. In one such case, that of a dislocated shoulder, reduction was followed by great swelling of the arm; a tumour formed in the axilla, which, at the end of thirty-eight days, burst with alarming hæmorrhage. Ligature of the subclavian artery fortunately saved the patient's life. In other cases, suppuration in and around the joint, and gangrene of the limb, have been known to ensue. (*b*) When the action of a new joint is less easy, and less efficient, reduction of the dislocation may be *attempted*, and with successful issue to limb and life.

The *kind* and *amount* of extension are, however, features in the treatment worthy of special attention. Extension, gradually increased, and continued for perhaps some hours, or renewed daily, is necessary, to overcome the resistance of the shortened muscles, any adhesions of the tendons or ligaments, and to extricate the bone from its new articular adaptations. But it should ever be remembered that, possibly, more than these *mechanical* obstacles to reduction exist. There is always some risk of rupturing any blood-vessels which may have become adherent. Yet this is an accident which cannot be foreseen, otherwise than by observing the general rule laid down respecting any surgical interference. Of course, reduction should be conducted under the influence of chloroform. When pain and swelling have subsided, in the course of a week or two, passive motion should be commenced.

The *extreme periods* of unreduced Dislocation, within which limits reduction is practicable, with safety to the limb and life of the patient, can scarcely be determined by experience. Nor is this question of much practical importance, considering the functional conditions, already mentioned, which should guide the Surgeon. Successful results have been obtained at extreme periods, varying from a few days to many months, and even beyond two years! In a dislocation of the *elbow*, backwards, unreduced for six months, Mr. Darke continued extension with pulleys during eight hours and a half, when the bones returned to their proper situation. Three other cases of this date were successful in the hands of Gorre and Gerdy. A dislocation of the *shoulder*, unreduced for six weeks, was overcome by Mr. Mash, in the Northampton Infirmary, by extension at intervals with *pulleys*, during eight hours. A dislocation of the head of the *radius* forwards, of twenty-five months, in a child nine years old, was reduced by Dr. Stark; extension being repeated daily for twenty-two days, consecutively. This is, I believe, the longest period at which extension has been successful, in unreduced dislocation of *any* joint in the upper extremity. *Manual* extension has proved sufficient in some cases. Thus, I reduced a dislocation of the radius *backwards*, of ten weeks; the adhesions about the head of the bone audibly giving way. In the lower extremity, the periods of limitation have been much less, with regard to the *hip-joint*. In two instances, dislocation of the femur on the dorsum ilii has been reduced after the lapse of six months. In both, reduction was effected by "manipulation;" the one under the influence of chloroform, the other, without; but in this case the patient, a boy, was feeble and the muscles flaccid. In both, the results were successful; the limb recovering its functions and the muscles

regaining their bulk and strength. Respecting the hip and shoulder joints; Sir A. Cooper's large experience led him to select two months in the one case, and three months in the other, as the extreme periods at which reduction can be *safely* accomplished. But the impossibility of determining the propriety of surgical interference by reference to the period of an unreduced dislocation must not be overlooked. In Fournier's specimen of hip-joint dislocation, the acetabulum retained its original character as an articular cavity after thirteen years had elapsed.

Any *opposing* tendons, ligaments, or adhesions suggest the propriety of a previous accessory operation; that of dividing them, subcutaneously. Simple as this may appear, it is not always practicable, with a fair degree of safety to the part, and even to the life of the patient. Yet there are successful results on record. Thus, in dislocation of the thumb backwards upon the metacarpal bone, reduction may be impossible, unless by subcutaneous division of the lateral ligaments. Sir Charles Bell first proposed the operation in this case, and it has since been successfully practised by Liston, Reinhardt, Gibson of Philadelphia, Parker of New York, and other Surgeons. Lizars and Syme advocate this practice in certain instances. An unreduced dislocation of the shoulder-joint, of two years' duration, was overcome by Dieffenbach, in like manner. In one instance also, an old dislocation of the elbow, which still resisted after division of the tendons and ligaments, was reduced by dividing the adhesions. M. Blumhardt made a longitudinal incision on either side of the joint, laid open the capsule, freely divided the adhesions, and replaced the bones. The limb is said to have recovered its natural mobility, and the patient resumed his occupation as a carpenter.

In cases such as these, the *periods* after dislocation at which operations have proved successful are comparatively unimportant; for the difficulties of reduction being thus overcome, the operation *itself* is the only important consideration, *i.e.*, as to its propriety and practicability.

Congenital Dislocations.—The whole pathology of "Dislocations existing at birth" requires further investigation, in respect to their structural conditions, causes, and vital history.

Congenital Dislocations are, apparently, of three kinds: (*a*) Physiological dislocations; or those resulting from an original defect in the germ, or from an arrest of development. (*b*) Pathological dislocations; or those resulting from some lesion of the nervous centres, from contraction or paralysis of the muscles, laxity of the ligaments, hydrarthrosis, or some other diseased condition of the articulation. (*c*) Mechanical dislocations; or those resulting from some peculiar position of the fœtus in utero, violent contractions or constant pressure of the walls of the uterus, falls and blows upon the abdomen, and unskilful manipulation of the child in delivery. These might be termed traumatic dislocations. Probably all the joints are liable to congenital Dislocation, in some form or forms; and with regard to most of the joints, this kind of lesion has already been established by dissection. Hamilton has collected many such instances; but it appears to occur most frequently in the hip and shoulder joints.

The *Treatment* of Congenital Dislocation is *generally impracticable*. What to do may be obvious; the removal of any one, or more, of the known conditions which originally produced the dislocation; but how

to do this successfully may be impracticable, owing to those conditions being, generally, defective forms of structure, which, in producing, also perpetuate the recurrence of dislocation. It is therefore mostly incurable.

CHAPTER XXXV.

SPECIAL DISLOCATIONS.

Dislocations of the Lower Jaw.—*Structural Conditions.*—*Complete* dislocation on *both* sides—double or bilateral dislocation—consists in the dislodgment of both condyles from the glenoid fossæ and their displacement forwards, in front of the anterior or transverse root of the zygoma, on either side; the coronoid processes thus being brought forward, and corresponding to the under aspect of the malar bone, on either side. (Fig. 338.) Similar displacement on *one* side only—single or unilateral dislocation—represents the same altered articular relations of the condyle, on that side; with a twist of the jaw to the opposite side. *Partial* dislocation, or subluxation of the jaw, is, apparently, a displacement in relation to the inter-articular cartilages; the condyles slipping forwards in front of these cartilages, on both sides, or on either side alone. Bilateral dislocation occurs in about two of every three cases. Partial dislocation happens comparatively seldom.

Fig. 338.

Signs.—Certain obvious and characteristic signs attend dislocation of the jaw. The mouth is open, the jaw being drawn down by the action of the genio-hyoid muscles, aided by the genio-hyoglossi, the digastric, and mylo-hyoid muscles; and the lower teeth project in front of the line of the upper teeth. This open-mouthed appearance is more conspicuous at first, the distance between the teeth extending sometimes to an inch and a half; subsequently the jaw become more closed, but the coronoid processes, hitching against the malar bones, mechanically oppose any nearer approximation. Deglutition and speech are interrupted, the lips moving when the person attempts to speak and the saliva dribbling over the chin. The cheeks are stretched and flattened, and the angles of the jaw directed somewhat backward towards the mastoid process of the temporal bone, on either side; a depression can be felt in front of the external auditory meatus, corresponding to the natural situation of the condyle, and an oblong prominence in the temporal fossa, with fulness of the masseter muscle. Dislocation on *one* side only is denoted by the same signs; but in a lesser

degree, and one-sided, the jaw being twisted somewhat to the opposite side, though this alteration may be scarcely appreciable. A depression can always be felt in the proper situation of the condyle, and not on the other side.

Partial dislocation presents similar signs, but they are still less perceptible, and perhaps recurring, the condyle slipping to and fro.

Causes.—Muscular action would seem to be the usual cause, in the act of opening the mouth widely; as in laughing, gaping, violent declamation, yawning, vomiting, convulsion, or an attempt to take too large a bite. The condyles moving forward on the transverse root of the zygoma on either side, are dislocated by the action of the external pterygoid muscles and anterior portion of the masseters, the genio-hyoid and other muscles then depressing the jaw. Consequently, the temporal, internal pterygoid and masseter muscles are placed on the stretch, or even strained. *External violence* is an occasional cause, as in tooth-extraction, or the forcible introduction of something into the mouth. Sir A. Cooper records such a case; two boys were struggling for an apple, and the one in attempting to thrust it into his own mouth, dislocated his jaw. *Age* would certainly seem to have some predisposing influence; complete dislocation occurring very rarely in infancy or advanced life, owing probably to peculiarities in the form of the jaw at these periods. Nélaton attributes its greater frequency in middle life to the length and anterior inclination of the coronoid process. *Women* also seem more liable than men; and to partial dislocation in particular, which arises probably from relaxation of the ligaments of the jaw.

Unreduced dislocation of the jaw undergoes changes, whereby the jaw becomes approximated to the upper, and its anterior projection is diminished; some mobility and power of movement also are regained; thus restoring mastication, deglutition, and speech so far, that the person at length experiences no great inconvenience from the displacement.

Treatment.—Reduction is readily accomplished by retracing the displacement. The Surgeon, standing in front of his patient, introduces his thumbs—protected by a cloth—into the mouth, and applies them to the lower molar teeth on either side; depressing the angles of the jaw, the chin is raised by the fingers externally at the same time, and the jaw is jerked in or returns with a snap. Chloroform may be administered, when reduction cannot be accomplished without its aid. Dislocation on one side is reduced in like manner; and so also partial dislocation, which may, however, be returned by the natural efforts to open and shut the mouth, the patient being told at the same time to make a lateral motion, or, as suggested by Professor Pirrie, to bring the jaw forward. A four-tailed bandage must then be applied, as in fracture of the lower jaw; and the patient fed on liquid food for some days, during reparation of the ligaments. After partial dislocation, the prevention of its recurrence may be aided by tonic treatment, and stimulant applications over the articulation.

Reduction has been effected after periods varying from days to several weeks; after one month and five days, by Sir A. Cooper, in a case of double dislocation; and after ninety-eight days, Donovan succeeded in another case.

Congenital Dislocation of the Lower Jaw—denied by Malgaigne, but affirmed by Guérin, R. W. Smith, and Hamilton—is, however, very rare. In Dr. Smith's complete account of one such case, dissection showed

an arrest of development of the dislocated side of the face, the osseous and muscular structures being atrophied and imperfect. A singular deformity of the face was thus occasioned on the one side, as compared with the other; and the usual signs of dislocation were absent or reversed,—the front teeth of the upper jaw projected beyond those of the lower, the mouth was closed or opened voluntarily, and these movements of the jaw were more extensive than in the normal condition.

This congenital dislocation is incurable.

Dislocations of the Spine—through the inter-vertebral substance—are almost necessarily accompanied with fracture of the articular processes, or of the bodies of the vertebræ; excepting in the cervical region, the articular processes there being placed more obliquely than those of the other vertebræ. Any dislocation of the spine is rare, and more so without fracture. The *displacement* may be forwards, and more commonly in this direction; lateral rotation, to either side; or backward displacement. It is always incomplete, except perhaps in the cervical vertebræ, which may possibly undergo complete displacement, forwards (Malgaigne). The *seat* of dislocation varies; this injury occurring in the cervical region most frequently, and particularly at the fifth or sixth vertebra; in the dorsal region occasionally, and particularly at the eleventh or twelfth vertebra; in the lumbar region very rarely, but perhaps at the first or second vertebra in this portion of the column. It appears, therefore, that spinal dislocation is more often met with in the cervico-dorsal and dorso-lumbar regions; at the junctions of curvatures, and of flexible to comparatively inflexible portions,—the weakest parts of the column. In all dislocations of the spine, the cord is more or less involved. Detachment of the *inter-vertebral substance*, with displacement of the bodies of the vertebræ, is a very uncommon form of injury. I have seen one such case in the cervical region of the spine, as shown by post-mortem examination.

Fig. 339.*

The *Signs* and *Symptoms* of spinal dislocation are similar to those of fracture in this region; some irregularity or projection at the seat of dislocation (Fig. 339), and paralysis, more or less complete, of those portions of the body which receive the nervous supply from below the point at which the dislocation has occurred. The diagnosis, as compared with fracture, can hardly be

* Royal Free Hospital. A case of partial dislocation, apparently, of the third and fourth cervical vertebræ, of some duration; unaccompanied with any symptoms of paralysis.

determined by crepitus, which may be absent in fracture, and present in all the dislocations accompanied with fracture; but a peculiar rigidity of the spine in the position assumed by dislocation, the trunk inclining immovably forwards, backwards, or more commonly to one side, will generally be diagnostic.

Causes.—The same as in fracture; falls on the head, feet, or back, and violent flexions of the spine backwards, or to either side.

Termination.—Dislocations of the spine are, obviously, of a serious or fatal character; and—like fracture—more so, the higher in the spinal column dislocation takes place.

Treatment.—Reduction of the displacement is impossible, or would be perilous; and but little can be done beyond the general treatment for fracture of the spine.

Dislocations of the first two cervical vertebræ are conveniently referred to the first bone. The *atlas* may be dislocated from the *occipital* bone; specimens of occipito-atloidean displacement having been reported by Lassus, Paletta, Bonisson, and Dariste. In each case, the displacement was incomplete; but death speedily ensued, except in the last case, where the patient survived for more than a year, and then died from tubercle in the brain. Dislocation of the atlas from the *axis*—atlo-axoid displacement—has been known to occur forwards or backwards, or as a lateral rotation of one articular process forwards. The ligaments which keep the odontoid process in place may or may not be ruptured. Thus, in forward dislocation of the atlas, the odontoid process of the axis passing backwards, may rupture the transverse ligament, with its superior vertical appendage, attached to the basilar portion of the occiput, and carry down also the odontoid and suspensory ligaments connecting the process with the condyles of the occiput. Or, with similar dislocation of the atlas, the odontoid process may slip from under the transverse ligament to behind it, leaving that ligament intact, but rupturing its inferior vertical appendage, attached to the root of the process, and also carrying down the odontoid and suspensory ligaments. In both these ligamentous lesions, the occipito-axoidean ligament—a continuation upwards to the basilar grove, of the posterior common ligament—must also be torn. Lastly, fracture of the odontoid process at its base may have occurred. The obvious importance of these lesions, accompanying dislocation, is their relation to the falling backwards of the odontoid process on to the spinal cord; complete compression causing instant death. This is said to be sometimes the mode of death in hanging; and it probably happened also in the sad case of the late Bishop of Winchester, who fell on his head from horseback, and died instantly.

DISLOCATIONS OF THE RIBS have been met with, occasionally, at either their *vertebral* or *sternal* articulations. In the former situation, the *head* of the rib is sometimes dislocated, and always forwards; generally one of the lower ribs, including the false or floating, has been thus displaced. This injury is usually associated with fracture of the transverse or spinous processes of the corresponding vertebra, or with fracture of another rib.

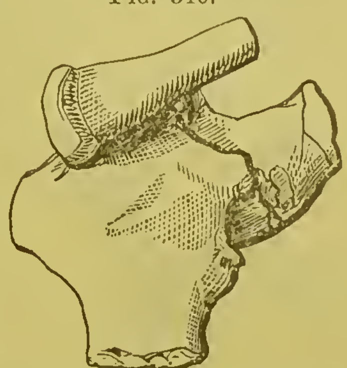
The *signs* of this dislocation will be obscure; the depression and mobility of the rib, adjoining the spine, might indicate fracture, and in such case the distinctive crepitus may be absent, owing to displacement, or imperceptible, through the depth of the fragments. Either injury also may arise from a fall or blow on the back.

The *treatment*, however, is the same in both cases. It will be found impossible to replace the head of bone, but rest of the part should be secured by a roller rib-bandage, to fix the chest until any inflammatory swelling has subsided.

At the *sternal* articulations, the rib-*cartilages* are liable to displacement forwards, in advance of the sternum, presenting one or more projections at the seat of the articulations. This displacement may be accompanied with fracture of the sternum. But, generally, it is the slow result of some habitual muscular action throwing back the shoulders, as by the use of dumb-bells "to open the chest," or of an occupation whereby, in using the arms, the ribs are pressed forwards, as in the act of kneading dough. I have known the dislocation to be produced in pigeon-breasted children. *Reduction* may be accomplished by pressing the cartilaginous projection back into place, aided by the patient making a full inspiration at the time, or by bending the trunk backwards. A compress and rib-bandage are then applied.

Dislocations of the Clavicle.—(1.) *The sternal end of the Clavicle* may be dislocated in three directions: *forwards*, in front of the sternum; *backwards*, behind the sternum; and *upwards*, or upwards and inwards, above the sternum. (Fig. 340.) In these dislocations, the ligaments are more or less completely torn, according to the direction and extent of the displacement; but the bone carries with it the clavicular portion of the sterno-mastoid muscle.

Fig. 340.*



Signs.—Dislocation *forwards* is denoted by a deformity, consisting of the sternal end of the clavicle in front of the sternum, which disappears by drawing the shoulders backwards and returns when such force is removed; the distance between the acromion and middle line is diminished; the head is drawn forwards and turned from the dislocation, in order to relax the sterno-mastoid muscle; and there is inability to raise the upper extremity. Dislocation *backwards* is denoted by the opposite appearance to the former one, a depression in the situation of the sternal end of the clavicle; but there may be dyspnœa, dysphagia, obstructed circulation and pain, from pressure on the trachea, œsophagus, vessels and nerves, respectively. Several cases are recorded in the "London and Edinburgh Journal of Medical Science," October, 1841. Dislocation *upwards* is of rare occurrence; four cases only have been collected by Malgaigne, and a fifth, an extraordinary case, by Hamilton, as described by Dr. Rochester in the "Buffalo Medical Journal." This form of dislocation presents a projection above the sternum—or in the remarkable case alluded to, upon the front of the thyroid cartilage—the sternal end of the clavicle having been thrown upwards; and there is also a corresponding depression of the shoulder.

Causes.—A fall on the shoulder, anteriorly, or throwing the shoulder

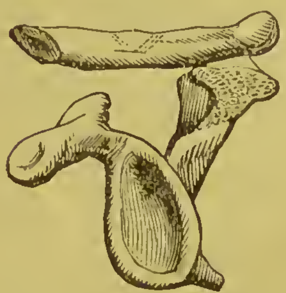
* St. Thomas's Hosp. Mus., B. 1. Dislocation of the sternal end of the clavicle, *upwards* and *inwards*, with fracture of the first rib close to the sternum. The articular end of the clavicle rests upon the concave upper border of the sternum.

backwards, may cause the dislocation forwards; compression of the shoulders, laterally, or a direct blow on the sternal end of the clavicle, may drive this portion of the bone backwards; and a fall on the shoulder externally, or a blow upon the top of the shoulder, may start the bone upwards upon the supra-sternal notch.

Treatment.—Reduction of these three dislocations is accomplished by directing the shoulder so as to retrace the particular displacement. *Forward* dislocation of the sternal end of the clavicle may be overcome by drawing the shoulder backwards and outwards; in *backward* dislocation, similar traction of the shoulder, to even a greater extent, will be efficient; while *upward* dislocation may be reduced by outward traction of the shoulder, at the same time raising the outer and depressing the inner end of the clavicle. Pressure directly on the displaced end of bone, when accessible, as in the first and last named dislocations, has comparatively little effect in aiding reduction. Traction of the shoulder is best effected by using the knee as a fulcrum in the back, while an assistant places his fist as a fulcrum in the axilla; the shoulders are then bent backwards, and the elbow brought down to the side, simultaneously.

To *retain* the bone in position, a pad over the sternal end may have some effect in dislocation *forwards*, but a figure-of-eight bandage applied to the shoulders will more effectually prevent the recurrence of displacement in *either* of the *three* directions of dislocation, the arm being drawn back and fixed to the side. Some permanent displacement and deformity are almost inevitable; the patient, however, recovering a good use of the arm. Indeed, it is a consolation to know that even when reduction has not been accomplished or maintained, almost the same good result has ensued.

Fig. 341.*



Compound dislocation occurred in one instance of dislocation backwards, by direct violence—a blow with a pick-axe. (Hamilton.)

(2.) *The scapular end of the Clavicle* may be dislocated—*upwards*, upon the upper surface of the acromion (Fig. 341); or *downwards*, under the acromion, or under the coracoid process. The first-named dislocation is the most frequent, and indeed the most common, of all dislocations of the clavicle; the second very rare, only three cases having been recorded of dislocation under the acromion, and six under the coracoid process. The acromio-clavicular ligaments are torn in the dislocation upwards; and also the coraco-clavicular and coraco-acromion ligaments in dislocation downwards.

Signs.—Dislocation *upwards* is easily recognized by the projection of the outer or scapular end of the clavicle, and which is more easily felt on tracing the spine of the scapula up to the acromio-clavicular articulation. Some depression and flatness of the shoulder will also be perceptible. Dislocation *downwards* is recognized, and distinguished, by the opposite signs; a marked depression, in particular, corresponding to the usual situation of the outer end of the clavicle. Downward dislocation, under the *coracoid* process, is more particularly characterized by a corresponding projection of the acromion and coracoid process,

* St. Thomas's Hosp. Mus., B. 2. Dislocation of the acromial end of the clavicle on the acromion or spine of the scapula, with fracture of the acromion.

and a rapid inclination downwards and outwards of the line of the clavicle, its outer end being felt in the axilla. Inability to raise the arm to a right angle with the body, will generally be found symptomatic of either form of dislocation; but the arm can be moved, passively, in certain directions. Thus, the range of motion is most free in the upward dislocation; whereas, in downward dislocation, under the acromion, the arm can be moved pretty freely backwards and forwards, but not outwards; and, with dislocation under the coracoid process, the arm cannot be moved inwards and upwards. Pain accompanies any opposed motion of the arm.

Causes.—A fall on the shoulder would seem to be the usual occasion of these dislocations; the force being applied upon the top or back of the shoulder, in upward dislocation; and upon the clavicle, to produce dislocation downwards. Thus, in one instance of the latter displacement, a horse trod upon the shoulder; and in another, the accident occurred to a child, from an attempt to support a great weight upon the top of the collar-bone. But the upward displacement may be caused by force from below; in one case having been produced by a bolt thrust up from under the clavicle.

Treatment.—Reduction is easily accomplished by drawing the shoulders backwards and outwards, the Surgeon placing his knee between them, as recommended by Sir A. Cooper. Considerable difficulty will, however, be experienced in preventing the recurrence of displacement. A pad in the axilla, and the application of a bandage, as for fractured clavicle, constitute the most effectual retentive apparatus. Direct compression is available only in dislocation upwards. Many weeks should be allowed to elapse before this treatment is discontinued. Some deformity almost always remains, but with little loss of power in the movements of the arm.

Dislocation of Both Ends of the Clavicle has been known to occur, simultaneously; but it must be placed among the rarities of Dislocations.

Dislocation of the Scapula.—The *lower angle* of the scapula sometimes projects, apparently having slipped from under the edge of the latissimus dorsi muscle, which there crosses the scapula. I have seen one such case, on the right side. Liston attributed this displacement to the arm being "suddenly raised above the head to an unusual extent." The vertebral border of the shoulder-blade projects to a great extent, and its inferior angle is so loosely connected to the chest, that the fingers may be pushed up between the ribs and the bone halfway to the glenoid cavity.

Fig. 342.

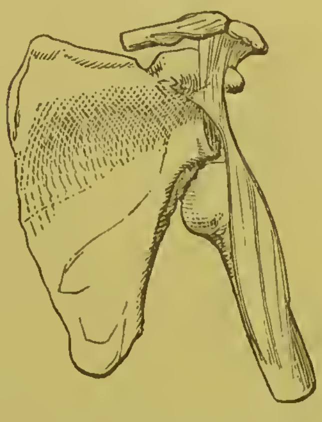
Some time since, Mr. Edmund Owen exhibited to the members of the Harveian Medical Society a boy who was the subject of this condition on both sides. Indeed, the shoulder-blades looked like rudimentary wings. This appearance was well marked in a case which Mr. MacCormac met with, as here shown. (Fig. 342.) Mr. Owen refers this

apparent dislocation of the scapula to *paralysis* of the *serratus magnus* muscle. The appearances come on slowly; if they were due to a sudden slipping of the bone over the latissimus dorsi, the patient or his friends would hardly say "the shoulder-blades have been growing out for weeks or months." The serratus magnus binds the scapula in its place against the ribs, and its inferior bundles play a most important part in raising the arm above the head. In the condition to which we are alluding, the power of elevating the arm is much impaired. The affection seems occasionally to follow a fatigue of the muscle. In another case cited by the same Surgeon, the patient, a nurse, attributed the weakness and pain in the shoulder to years of attendance on an old lady, whom she used to rub for chronic pleurisy. The clinical history of "paralysis of the serratus magnus" is recorded in a case which Dr. Vivian Poore brought before the Clinical Society of London, February 12, 1875.

Treatment.—The treatment, observes Mr. Owen, should consist in rubbing and shampooing, and in the use of the interrupted current. One may give a more favourable opinion of the result if, on passing the current down the course of the nerve of Bell from the root of the neck to the costal attachments of the muscle, the scapula is braced up into its proper position. Bandaging the chest is futile; and if the surgical mechanician is intrusted with the treatment of the case, he will probably supply an ingeniously constructed corset, whose expense is only equalled by its uselessness.

Dislocations of the Shoulder-Joint.—These are the commonest of all Dislocations. The head of the humerus may undergo displacement—downwards, into the axilla, *subglenoid;* forwards, *subcoracoid* and *subclavicular;* backwards, on the dorsum of the scapula beneath its spine, *subspinous.* These dislocations occur in the same order of relative frequency; the first named being by far the most common; the second, occasional; and the third, very rare. Subcoracoid dislocation may, however, be the most frequent; Professor Flower's investigations showing that of 41 specimens in the Museums of the London Hospitals, 31 are subcoracoid; and that in 50 cases known to him, 44 were of this form.

Fig. 343.*



Partial dislocation is said to occur; either as the subcoracoid, or a dislocation upwards —supra-glenoid—under the acromion. But the former dislocation is complete, the head of the humerus being lodged entirely out of the glenoid cavity, in the illustrative case given by Sir A. Cooper; the upward dislocation is incomplete, the head of the bone lying partly in the glenoid cavity.

Structural Conditions.—(1) Dislocation *downwards* or *subglenoid;*—the head of the humerus is lodged in the axilla, just below the glenoid cavity, and resting on the inferior costa of the scapula (Fig. 343), between the subscapular muscle and the long head of the triceps. The capsular ligament is torn to a

* St. Thomas's Hosp. Mus., B. 8. Dislocation of the head of the humerus downwards into the axilla. The capsular ligament is laid open in front, and the head of the bone rests on the inferior costa of the scapula, beneath the glenoid cavity.

considerable extent, and generally the tendon of the subscapular muscle, near its insertion into the small tuberosity. The muscles attached to the great tuberosity are stretched or torn, particularly the supra-spinatus; and, possibly, the tuberosity itself may be detached. The axillary vessels and plexus of nerves suffer compression by the head of the bone.

(2.) Dislocation *forwards*, and *subclavicular;*—the head of the humerus lies under the pectoral muscles, on the inner side of the coracoid process, just below the clavicle (Fig. 344), and resting on the second and third ribs. The capsule may be completely separated from the neck of the bone; the lower scapular muscles much torn, namely, subscapularis detached from the smaller tuberosity, infra-spinatus and teres minor from the great tuberosity; and, possibly,

FIG. 344.*

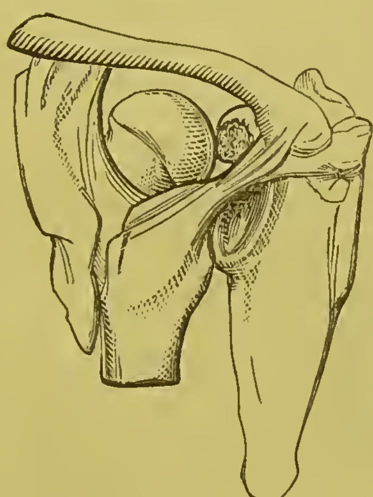
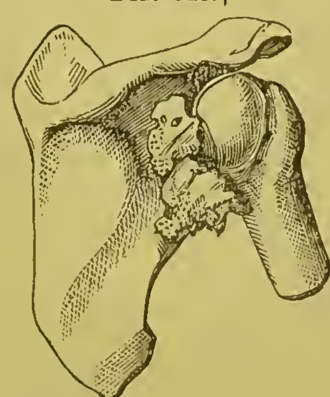


FIG. 345.†



this prominence of bone may itself be torn away from the head of the humerus. The axillary vessels and nerves suffer compression.

(3.) Dislocation *backwards*, or *subspinous;* the head of the humerus lies just behind the glenoid cavity on the dorsum of the scapula, below its spine (Fig. 345), and between the infra-spinatus and teres minor muscles. The capsule is ruptured, and the muscles in front of the joint are stretched or torn; namely, the subscapularis, supra-spinatus, and long head of the biceps.

Partial dislocation *upwards* produces structural alterations, but

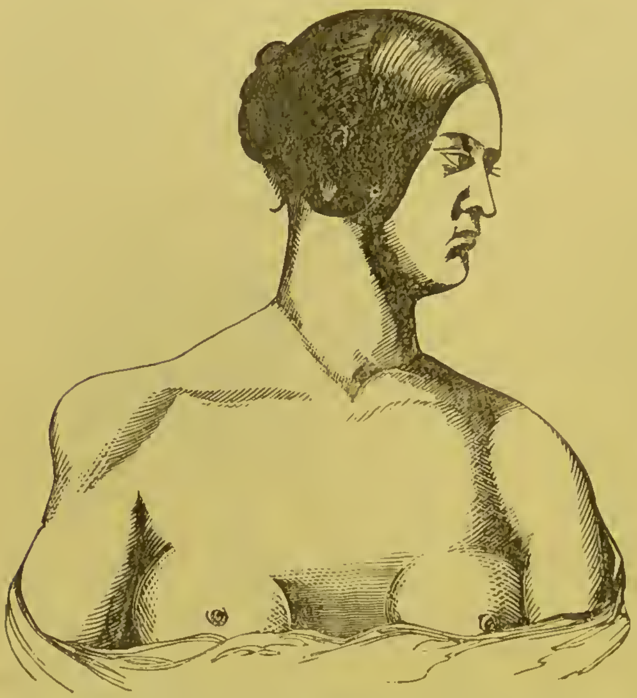
* St. George's Hospital Museum, 1, 107. Dislocation of the head of the humerus upwards and forwards, with *fracture* of the *coracoid process.* The head of the humerus—as primarily displaced—rested on the anterior margin of the clavicle, just external to the junction of the pectoralis major and deltoid muscles, quite above the level of the glenoid cavity. In the figure, as from the preparation, it has fallen to the same level as that cavity. Owing to the fracture of the coracoid process, on which the head of the humerus also partly rested, erosion of the articular cartilage has taken place, producing *crepitus*, when the head of the bone was rotated against it. The stump of this process appears behind the humerus in the figure. Its tip, not shown, was slightly separated by the tendons inserted into it, but the ligamentous fibres attached to the coracoid process opposed further displacement. The long tendon of the biceps was not ruptured. The injury was caused by a fall on the elbow, from a height of about thirty feet; and the patient, a man aged 49 years, lived for a fortnight. For any further particulars, see "Med. Chir. Trans.," vol. xli.

† St. Mary's Hospital Museum, A. *a*. 8. A very rare specimen.

less extensive. In two cases (see supra-glenoid dislocation) the head of the humerus was partly dislodged upwards, under the acromion; the capsule was slightly ruptured, and the long tendon of the biceps thrown out of its groove inwards, on to the smaller tuberosity of the humerus.

Signs.—Certain signs are common to all three dislocations of the shoulder. These signs are—flattening of the shoulder, externally; a depression below the acromion, owing to the absence of the head of the bone, and a corresponding projection of the acromion above (Fig. 346); the presence of the head of the bone in an abnormal situation, downwards, forwards, or backwards; some immobility, and inability to use the arm, and pain, particularly when the arm is moved. But the direction of the axis of the humerus or arm, and the length of the arm, with the situation of the head of the bone, are distinctive in each form of dislocation; thereby determining its diagnosis.

Fig. 346.



Dislocation *downwards* into the axilla is accompanied with some inclination of the arm *outwards*, in a line with the trunk, and neither backwards nor forwards; an elongation of the arm is observable, or can be ascertained by measurement,—taking the apex of the acromion as a fixed point above the joint, and the external condyle of the humerus below. The head of the humerus can be felt in the axilla.

Dislocation *forwards*, or subclavicular, is distinguished by a direction of the arm *backwards*, and somewhat outwards; with some shortening. The head of the bone can be felt under the clavicle.

Dislocation *backwards*, or subspinous, is characterized by a direction of the arm *forwards*, and somewhat outwards, or occasionally it hangs by the side; with some shortening. The head of the bone can be felt under the spine of the scapula.

Partial dislocation upwards (see supra-glenoid dislocation) is characterized, principally, by the position of the head of the bone, which appears to be drawn higher up in the glenoid cavity, and unnaturally prominent in front; abduction produces a sensation of crepitus, the humerus rubbing under the acromion, and becoming locked as the arm is raised; and severe pain is experienced by any action of the biceps muscle.

But the detection of any form of dislocation of the shoulder-joint, downwards into the axilla more particularly, may be rendered difficult,

a few hours after the accident, by the supervention of swelling, both from inflammatory effusion and extravasation of blood ; the nature of the injury becoming more perceptible as the swelling subsides. This condition might mislead the Surgeon more readily, when the dislocation was caused by direct violence, in so far resembling simply a contusion of the shoulder.

The *Diagnosis* of shoulder-joint dislocation, as compared with *fractures* of the neck of the humerus, may be determined by the presence of the signs common to all these dislocations, and the absence of true crepitus. *Atrophy* of the deltoid muscle, resulting from contusion or other injury, simulates dislocation only by the flattening of the shoulder, and the overhanging acromion.

Causes.—Direct violence, as a fall on the shoulder, in the direction opposite to the particular form of dislocation. Thus, a fall from a height on the top of the shoulder may occasion dislocation downwards; upon the back of the shoulder, it may cause dislocation forwards; and a fall on the front of the shoulder has been known to produce dislocation backwards, or collision of the front of the shoulder against a tree, in the case of a person being thrown from a horse. *Indirect* violence applied to the arm, when itself in a position favourable to the particular form of dislocation. Thus, forcible abduction of the arm may occasion dislocation downwards; and I have known it produced, as a recurring dislocation in an elderly gentleman, by merely resting the fingers on a chest of drawers, the arm being fully extended. Violent contraction of the deltoid, in lifting a heavy weight, has also tilted the head of the bone downwards, out of the glenoid cavity. A fall on the elbow, the arm being directed backwards, may occasion dislocation forwards; and dislocation backwards has been produced by pushing a person violently, with the arm elevated. Spasmodic contraction of the muscles during an epileptic fit, was the cause of the former dislocation, in a case which Hamilton met with, and of the latter dislocation, in a case examined after death by Mr. Key.

The causative relation of shoulder-joint dislocations to each other is worthy of notice. Dislocation forwards—subclavicular—may result as the completion of a subcoracoid displacement, which is then regarded as a *partial* dislocation forwards. Or, the subclavicular dislocation may, it is said, be consequent on dislocation downwards. Sir A. Cooper regarded the former as a primary dislocation; other eminent Surgeons—for example, Desault, Petit, Dupuytren, Mr. Hey, and Professor Samuel Cooper—did not deny the possibility of its being primary; but they believed it to be very seldom so, and almost always secondary to dislocation downwards.

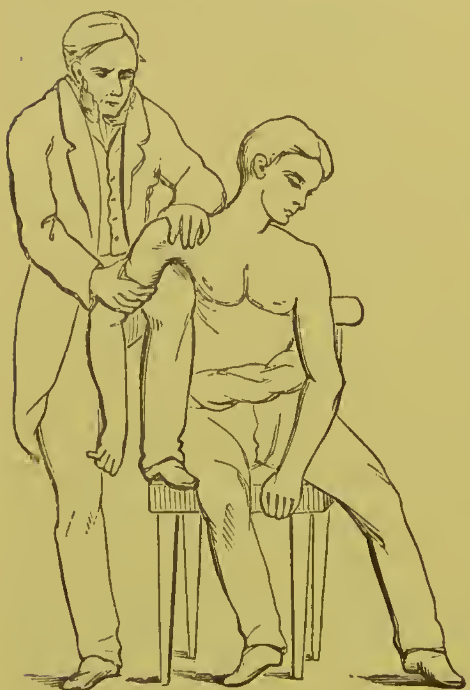
Unreduced dislocation of the shoulder-joint is followed by the slow formation of a new articulation, and destruction of the glenoid cavity ; with proportionate recovery of the use of the arm. Thus, in an old dislocation downwards—described by Sir A. Cooper—the head of the bone had become flattened, and a new shallow cavity had formed for the reception of the head on the inferior costa of the scapula anteriorly, a complete capsular ligament also surrounding the head; while the glenoid cavity was entirely filled with ligamentous matter, in which were suspended small portions of bone, evidently of new formation, as no portion of the scapula or humerus was broken. *Reduced* dislocation is followed by good recovery of the use of the arm; some

stiffness, weakness, pain, and swelling of the shoulder-joint remaining, perhaps, for a considerable period, when reduction had been delayed, or attended with much extension, or when the joint had sustained previous contusion. Under these unfavourable circumstances, there is also an increased liability to re-dislocation. Aggravated by its recurrence, the looseness of articulation ultimately may be such that dislocation takes place on the slightest occasion of force in the right direction. In the case already alluded to of an elderly gentlemen, dislocation downwards into the axilla had been overlooked by an Hospital Surgeon in attendance for three weeks; and, after reduction by Sir William Fergusson, it recurred four times in a period of eighteen months. Upward motion of the arm was afterwards restrained by wearing a belt around the chest, attached to an arm-loop, and the dislocation has not since returned.

Treatment.—Reduction may be effected in various ways:—

(1.) By *direct* extension and counter-extension. This method is perhaps most generally applicable. The patient being seated in a chair, a sheet or jack-towel is drawn under the axilla on the dislocated side, around the chest over the opposite shoulder, and attached to some fixed, resisting object, or held by assistants. Extension is made from the arm or wrist, by means of a linen band fastened by a clove-hitch knot. The arm should be drawn out at a right angle to the chest, and extension slowly maintained, by an assistant, or by pulleys, when necessary. The Surgeon placing his knee in the axilla, and depressing the shoulder with one hand, while he slightly inclines the arm downwards with the other, the head of the bone passes into the glenoid cavity with a jerk or snap, announcing the reduction. Extension is discontinued, and the arm brought to the side should be secured by a few turns of a roller around the chest, supporting the elbow by a few turns below. An axillary pad may be advisable in dislocation downwards. Any inflammatory swelling about the joint will subside, or can be readily subdued by cold evaporating lotions. I have thus reduced nearly all the dislocations of the shoulder which have fallen to my lot. But the inconvenience of this method in private practice is the assistance requisite, despite the relaxing influence of choloroform, and its administration would necessitate having another assistant.

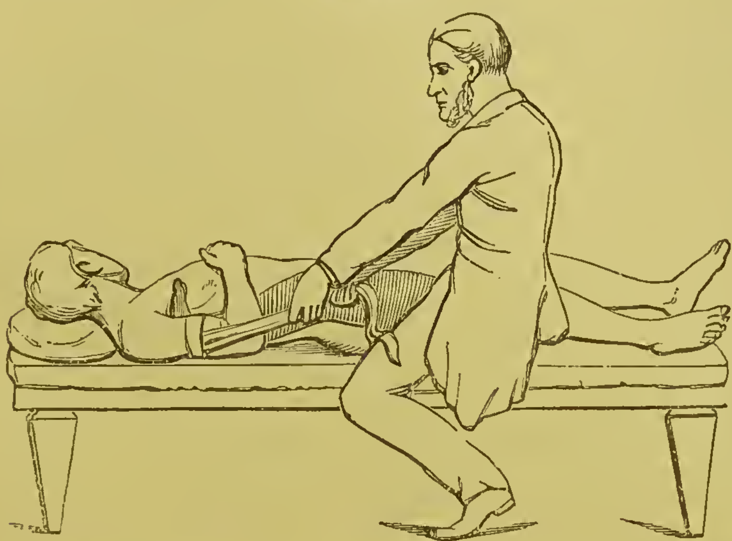
Fig. 347.



(2.) By the *knee* in the *axilla*, reduction can be effected without extension; simply by drawing the arm well down over the knee, as a fulcrum, depressing the shoulder, at the same time, with the other hand. This was one of the methods recommended by Sir A. Cooper. (Fig. 347.)

(3.) By the *heel* in the *axilla*. The patient lying recumbent, the Surgeon, sitting on the edge of the couch, plants his foot well up into the axilla, and drawing the limb well downwards, inclines it inwards across the foot as a fulcrum. This also was another method employed by Sir A. Cooper. (Fig. 348.) Instead of the heel, Skey employed a well-padded *iron knob*, in the axilla; this fulcrum being furnished with two iron branches, to which are attached the cords for counter-extension, while extension is made by means of pulleys from the wrist or from the arm, the limb lying parallel to, and in contact with, the trunk.

Fig. 348.



This method of reduction may be necessary in a very muscular subject, or in unreduced dislocations of some duration.

(4.) By *raising* the *arm*.—The patient lying recumbent, the Surgeon, sitting behind the shoulder and fixing it with one hand, raises the arm up perpendicularly; then bringing it down suddenly to the side, the head of the bone may snap into place.

(5.) Dislocation *backwards* may sometimes be readily reduced by bending the *arm backwards*, and at the same time drawing *forward* the *upper end* of the *humerus* with the other hand.

(6.) Reduction by *manipulation* has been proposed, and practised, by Professor H. H. Smith, of Philadelphia. This method is said to be applicable to nearly *all* dislocations of the shoulder-joint, but it would appear to be specially eligible in dislocation *downwards* into the axilla. It consists, "first, in flexing the forearm upon the arm, and at the same moment the elbow is lifted from the body; secondly, in rotating the humerus upwards and outwards, using the forearm as a lever; thirdly, in reversing this last movement by rotating the humerus downwards and inwards, while at the same moment the elbow is brought down again to the side." In dislocation *forwards*, this method of attempted reduction would inevitably increase the displacement,—rotation of the humerus upwards and outwards would have the effect of driving the head further forwards.

Unreduced dislocations of the humerus are to be overcome by one or other of these methods; generally, by direct extension and counter-

extension, under the influence of chloroform; aided, perhaps, by pulleys for making extension, which should be slowly maintained. Dr. Jarvis's "adjuster" has proved effectual when other means have failed. Its principal advantage is that during extension, the limb can be moved about freely in all directions, without relaxing the extension.

The *periods* after dislocation when reduction has been accomplished, vary as to their extreme duration; a month, in one of my own cases; after twenty-five weeks, by Mr. Brodhurst; after seven months, and ten months and a half, by Mr. Smith, of the United States. Dieffenbach accomplished the reduction of a dislocation forwards after two years' duration; but not until he had cut the tendons of the pectoralis major, latissimus dorsi, teres major and minor, and had divided the ligaments surrounding the new joint.

The *extreme period* for the *safe* reduction of dislocation is probably best determined by observing the movements afforded by the new joint; and which indicate also the probable *utility*, or otherwise, of reduction, although itself practicable. *Accidents*, of a most serious character, are liable to happen in the reduction of old standing dislocations; laceration of the muscles and tendons, rupture of the axillary vessels and nerves, or fracture of the neck of the humerus. Or inflammation may speedily ensue, with suppuration in and around the joint. These lesions, or consequences, sometimes occur apart from any inconsiderate application of extending force.

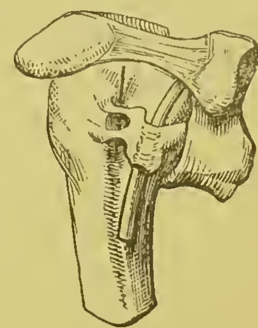
Compound dislocation of the shoulder-joint is a rare form of injury. Erichsen mentions having seen two cases, and in two directions of dislocation: inwards—subcoracoid, and downwards—subglenoid; to which may be added one more, into the axilla, as recorded by Hamilton among his own cases; and a compound dislocation of the shoulder by Sir A. Cooper.

Treatment.—Reduction was effected in both Mr. Erichsen's cases, and they did well. The question of *amputation* must be determined by reference to the considerations which render the sacrifice of the limb inevitable in COMPOUND DISLOCATION, generally; and principally, regarding the injury to the axillary vessels and nerves.

Complicated Dislocations of the Shoulder-joint.—(1.) *Displacement* of the *long head* of the *Biceps* muscle, and *Supra-glenoid Dislocation.*—In a few instances only, the long head of the biceps has been found displaced *inwards* from the bicipital groove, and the head of the humerus *partially* dislocated *upwards* above the glenoid cavity,—resting under the acromion or the coraco-acromion ligament. This anomalous form of double displacement was first verified by dissection in a case described by Mr. John Soden, jun., of Bath, and which is recorded in the "Royal Med.-Chir. Trans.," 1841. An injury to the right shoulder-joint was produced by a fall backwards, the whole weight of the body being received on the elbow. When the intense inflammatory swelling of the shoulder had subsided, the following *symptoms* were presented:—A globular swelling, as if the head of the humerus beneath the acromion process of the scapula, with slight flattening of the shoulder; and some crepitation could be felt, when the shoulder was grasped above, and the arm was raised upwards and outwards,—this sensation arising from the attrition of the head of the bone beneath the acromion; but the movement of abduction was limited, and the power of such motion was nearly lost. Thus, the man could move his arm backwards and for-

wards, but was unable to lift the slightest weight; and any motion of the biceps muscle was attended with great pain. This state having continued for two years, death occurred from a compound fracture of the skull; and post-mortem examination discovered the real nature of the former injury. The capsular ligament had been slightly rent, and the long tendon of the biceps, thrown out of its groove, inwards, was lying on the smaller tuberosity of the humerus (Fig. 349); with this displacement, the head of the bone, being no longer kept in position, was partly dislocated upwards from the glenoid cavity, lying beneath the acromion, and directed somewhat inwards toward the coracoid process.

Fig. 349.*



In a second case, Mr. Soden found the dislocation to be somewhat forwards, as well as upwards, in connection with inward displacement of the tendon, and to such an extent that it lay on the inner and posterior aspect of the joint.

Prior to these observations, Mr. Stanley had called attention to this form of injury in the "Med. Gazette," vol. iii.; and in the 14th vol. of the same journal, Mr. Gregory Smith describes seven specimens met with in the dissecting-room, some of which showed the same altered relation of the bones, and in all of which the tendon was more or less injured,—in five it had been ruptured, and in two it was displaced from its groove. In one case, related by Mauget in the "Encyclopédie Methodique," the tendon appeared to be "dislodged to the outer side of the groove, for the elbow was immovably flexed."

Professor Pirrie has since met with an additional instance of this double form of injury to the shoulder-joint; that case also having been verified by dissection. A case may be mentioned in which a similar inward displacement of the biceps tendon and upward dislocation of the humerus had taken place, but slowly, as the result of destructive *disease* of the shoulder-joint; the nodulated character of the head of the bone, from ossific deposit, plainly distinguishing this condition from the effects of injury. The preparation will be found in the Museum of St. Mary's Hospital.

(2.) *Dislocation, with Fracture of the Humerus in its Surgical Neck or in the Shaft.* In a well-marked case of dislocation of the head of the humerus forwards and upwards under the clavicle, there was also fracture of the surgical neck of the bone. This double injury having happened to a boy at the age of nine years, it is probable that the apparent fracture was a separation of the upper epiphysis of the humerus. On examination, I found a large globular swelling in the subclavicular hollow on the right side, and externally, beneath the deltoid muscle and under the acromion, another projection; the one was plainly the head of the humerus, the other the broken end of that bone. These two projections together gave a remarkably enlarged appearance to the whole shoulder. (Fig. 350.) The arm was much shortened from the elbow, and the humerus was directed obliquely outwards from the side. On extension, the dislocated head could be readily reduced, by pressure with the fingers, into its natural position in the glenoid

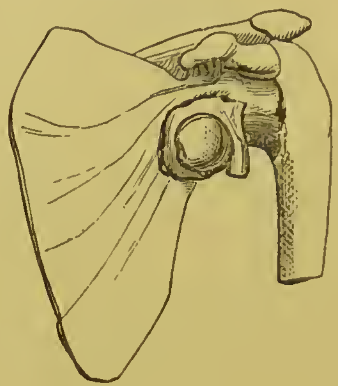
* King's College Museum, 1341.

cavity, and tho fracture being reduced at the same time, the shoulder regained its natural size and shape; but on relaxation, the head of the humerus immediately became redislocated, and the fractured end of the bone passing upwards and outwards, the peculiar appearance of the shoulder was easily reproduced.

In the following complication of injury to the shoulder-joint, the fracture having detached the head and small tuberosity of the humerus,

FIG. 350.*

FIG. 351.†



this portion of bone is dislocated forwards and inwards on the ventral aspect of the scapula, half an inch below the base of the coracoid process; the articular surface of the head looking almost directly forwards. (Fig. 351.) The subscapularis tendon remains attached to the small tuberosity, the broken surface of which is firmly united to the anterior part of the great tuberosity. The fractured end of the shaft of the humerus and of the great tuberosity, has passed into the glenoid cavity of the scapula, and has there become fixed; and the tendons of the supra-spinatus and infra-spinatus muscles still remain attached to the great tuberosity.

The *treatment* of these complicated injuries of the shoulder is the only peculiarity of practical importance; as to whether the dislocation or the fracture should be reduced first? The former manipulation can generally be accomplished without much difficulty. Extension will hardly avail much, or indeed be necessary, in effecting reduction of the dislocation. Pressure on the head of the bone, aided by the relaxing influence of chloroform, has proved quite sufficient. Failing in this way, the fracture may be reduced and put up firmly, thus allowing of extension, or one of the other methods for reduction of the dislocation. Failing still to reduce the dislocation, the fracture must be alone regarded; and then, at the earliest period after union of the fragments, reduction of the dislocation should again be attempted. This latter was the primary rule of treatment at one time, and it led to many successful results. But it implied that which experience has since disproved, the impossibility of reducing these complicated dislocations until the fracture had united.

(3.) *Dislocation* forwards and inwards, complicated with fracture of the scapula—the tip of the coracoid process and end of the acromion, and of the clavicle in its outer curve. (Fig. 352.) Tho head of the

* Royal Free Hospital. (Author.)
† Roy. Coll. Surg. Mus., 875. (Sir A. P. Cooper.)

humerus rests against the anterior margin of the glenoid cavity, and the capsule is laid open behind; the fragment of the coracoid process is attached to the coraco-brachialis muscle. The biceps tendon is uninjured.

Fig. 352.*

Congenital Dislocations of the Shoulder-joint.—Three varieties are recognized by Guérin: dislocation of the head of the humerus downwards; downwards and inwards, the head of the bone resting against the ribs; and subluxation upwards and outwards, the head of the bone sliding in this direction, favoured by a corresponding displacement of the coracoid and acromion processes. Dr. Robert Smith has met with only two forms of congenital dislocation of the humerus, subcoracoid and subacromial; of the former he has seen several examples. These dislocations, arising from either a paralytic condition of the muscles, or from developmental imperfections of the articulation, are necessarily incurable.

Dislocations of the Elbow.—This joint is liable to eight recognized dislocations; four of which relate to both bones, one to the ulna alone, and three to the radius alone. Thus, (1) dislocation of both bones backwards; (2) outwards; (3) inwards; (4) forwards; (5) dislocation of the ulna alone, backwards; (6) dislocation of the radius alone, backwards; (7) forwards; (8) outwards. To these recognized dislocations may be added another; dislocation of both bones outwards, and upwards *laterally* on the humerus, constituting an "external latero-angular dislocation" of the elbow-joint, as I so named this form of dislocation, in the only instance I have ever seen or can find recorded. (See Fig. 334.)

Structural Conditions.—(1.) Dislocation of the *radius and ulna backwards* is the most frequent form. The head of the radius is lodged behind the external condyle, and the coronoid process of the ulna lies in the olecranon fossa; the lower end of the humerus resting on the anterior surface of the radius and ulna. (Fig. 353.) All the four ligaments are ruptured, leaving only some of the fibres of the internal lateral one. The annular ligament remains entire. The brachialis anticus and biceps muscles are stretched or torn, the former sometimes carrying away a portion of the coronoid process; but the other muscles are relaxed, the triceps posteriorly, and all the muscles originating from either condyle of the humerus, excepting the supinator radii brevis. The median nerve is pressed forwards by the humerus; and the ulna nerve is, sometimes, painfully stretched over the projecting extremity of the ulna backwards. In the specimen represented there is an old unreduced dislocation of both bones of the forearm backwards. The head of the radius is lodged at the back of the external condyle, where

Fig. 353.†

* St. Thomas's Hosp. Mus., B. 12.

† St. George's Hosp. Mus., 1, 108.

a new articular cavity is formed for it, by the deposit of new bone, thus allowing of some amount of motion. The coronoid process, lodged in the olecranon fossa, was almost immovable. The brachialis anticus muscle is torn away from its insertion to the coronoid process, and was adherent to the lower end of the humerus; also to the ulna, below the coronoid process.

FIG. 354.*

(2.) Dislocation of the *radius and ulna outwards*, or to the radial side (Fig. 354), is far less frequent than the foregoing, and usually incomplete; complete dislocation having been known to occur in only 11 cases (Malgaigne), and all of which were met with in the practice of French Surgeons. *Incomplete* dislocation; the ulna still articulates with the humerus, but the great sigmoid cavity is carried outwards from the trochlea, so that its central crest rests upon the depression which separates the capitellum from the trochlea. If the annular ligament remains unbroken, the radius is displaced in the same direction and to the same extent, its head resting against and directly below the outer condyle. More complete dislocation may occur, and complete dislocation, rarely; the head of the radius being, perhaps, thrown forwards or backwards. The specimen figured exhibits an unreduced dislocation of the radius and ulna *outwards*, and partially backwards, with osseous union in their displaced position. The olecranon and coronoid process, and the greater portion of the sigmoid cavity of the ulna, are thus united to the middle of the posterior surface and margin of the external condyle of the humerus. Fracture of the external condyle seems also to have occurred. The articulation between the radius and ulna is natural; and the radius, being fixed only by ligament to the humerus, may have had full freedom of motion. In a similar specimen—dislocation of the head of the radius outwards, and of the ulna backwards and outwards—a *new joint* is formed, in the form of a cup, partly bony, for the head of the radius. The inner condyle appears to have been fractured. (St. Thomas's Hosp. Mus., B. 14. Sir A. Cooper.)

A *variety* of this dislocation is outwards and *upwards* or *backwards;* the olecranon process of the ulna lying above and behind the outer condyle.

The NEW *variety*, to which I have alluded, is a complete dislocation of the radius and ulna outwards and upwards *laterally;* the large sigmoid cavity of the ulna embracing the outer condyle and capitellum, just behind its articular surface, at a right angle, externally, with the humerus; and the head of the radius above, being in close relation to the external ridge of the humerus, which (ridge) bisected its round cup-like cavity. The head of the radius, therefore, was neither wholly in front nor behind the humerus; it was not dislocated forwards or backwards.

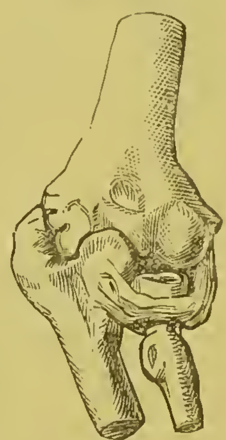
In outward dislocations, the ligaments are more or less completely torn; but, in the ordinary forms of such dislocation, the brachialis anticus and anconeus are the only muscles much disturbed, the biceps and triceps traversing the articulation a little more obliquely; while the principal arteries and nerves do not suffer much, if at all.

* Roy. Coll. Surg. Mus., 878. (G. Langstaff.)

In the variety which I have described, the state of the muscles is also fully noticed with the arteries and nerves; of which the latter structures had singularly escaped injury.*

(3.) Dislocation of the *radius and ulna inwards*, or to the ulnar side, is much more rare than dislocation outwards, and always incomplete, no example of complete dislocation inwards having been recorded. The ulna is driven over the elevated inner ridge of the trochlea, and falls down on the inner condyle, or epi-trochlea, embracing it instead of the trochlea; while the head of the radius, passing inwards also, occupies the trochlea. (Fig. 355.) The head of the radius is generally in the same line with the ulna; but it may be found a little forwards or backwards.

Fig. 355.†



A *variety* of this dislocation is inwards and *upwards* or *backwards;* the coronoid process of the ulna being thrust upwards above the inner condyle, and the head of the radius occupying the olecranon fossa.

The ligaments and muscles suffer some injury, and the ulnar nerve is peculiarly liable to contusion between the olecranon and inner condyle.

(4.) Dislocation of the *radius and ulna forwards* was considered impossible without a fracture of the olecranon, this opinion having been taught by Sir A. Cooper and Vidal (De Cassis); but Monin, Prior, Velpeau, Canton, and Denucé have each reported one example—five in number. The structural condition of this dislocation requires further elucidation. In Velpeau's case, the head of the radius rested in the coronoid fossa, and the olecranon was carried upwards and a little outwards; whereas in Mr. Canton's case, as depicted in Hamilton's work, the olecranon rested, apparently, on its summit against the forepart of the articular surface of the humerus, and the head of the radius was free lower down in the smaller sigmoid cavity of the ulna; thus constituting a *complete* dislocation of both bones forwards.

(5.) Dislocation of the *ulna alone, backwards*, seldom happens without some dislocation of the head of the radius; yet it is possible that the coronoid process may pass backwards into the olecranon fossa. (A. Cooper.) In one recorded dissection of such dislocation, observes Professor Pirrie, the coronary, oblique, and part of the interosseous ligaments were torn; the brachialis muscle was stretched under the humerus, and the triceps much relaxed.

(6.) Dislocation of the head of the *radius alone, backwards*.—This dislocation is of rare occurrence, only twenty-eight supposed examples having been collected. One only had been verified by dissection, and this is reported by Sir A. Cooper. The head of the radius was behind the external condyle of the humerus, and rather to the outer side. The coronary ligament was torn through at its forepart, and the oblique had given way. The capsular ligament was partially torn, and the head would have receded much more, but it was supported by the aponeurotic fascia. But I may add the following specimen. (Fig. 356.) The bicipital tuberosity lies close to the unoccupied lesser sigmoid notch. The orbicular ligament still en-

* "British and Foreign Med.-Chir. Review," Jan., 1866.
† Guy's Hosp. Mus., 1306.

closed the neck of the radius, but its attachments to the ulna were ruptured, and it had become firmly united to the humerus on either side of the dislocated bone. Accordingly, the movements of pronation and supination could not be performed. The ulna allowed of flexion and extension through about a fourth of the natural extent of these motions. The outer condyle of the humerus is altered in shape, from the deposit of new bone. This dislocation had existed for about two years, and was caused by direct violence, the elbow having been struck

FIG. 356.*

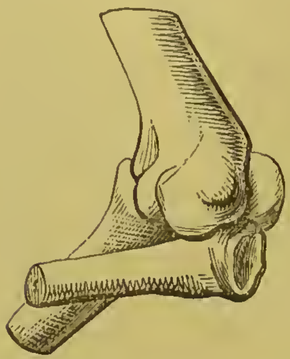
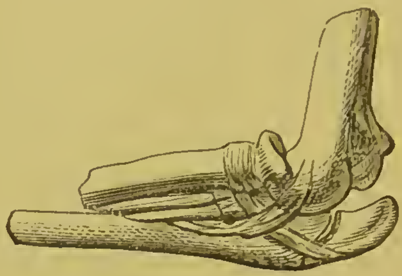


FIG. 357.†



by a stone. *Incomplete* dislocation, as occasionally happens in children, may not be attended with rupture of the annular ligament.

(7.) Dislocation of the head of the *radius alone, forwards*, is relatively more common than backward dislocation; although Boyer, Velpeau, Chelius, Gibson (of Richmond), Va., B. Cooper, and other Surgeons of large experience maintain the contrary. The head of the radius lies in front of the humerus, and generally somewhat outwards. (Fig. 357.) The anterior and external lateral ligaments, with the annular, are usually more or less torn. Sometimes, the two former are alone broken, the annular ligament also being sufficiently stretched to allow of complete dislocation; or, the anterior and annular having given way, the external lateral remains intact. In the specimen I have figured, dislocation of the head of the radius forwards was complicated by *fracture* of the *epiphysis* of the *olecranon*, and fracture also of the ulna below its middle. The dislocation was *compound*, a large lacerated wound having been caused by the passage of a carriage-wheel over the arm, in the person of a child two years old. Death occurred from pyæmia.

FIG. 358.‡

(8.) Dislocation of the head of the *radius alone, outwards*, is a modification of, if not consequent on, forward dislocation, or, perhaps, backward dislocation. The head rests on the outer side of the external condyle. It is a very rare displacement, Denncé having collected only four examples, unaccompanied with fracture. In the annexed illustration, the radial dislocation outwards is associated with displacement of the ulna backwards and outwards, and fracture apparently of the inner condyle. (Fig. 358.)

* St. George's Hosp. Mus., 1, 109. † Ibid. 1, 110.
‡ St. Thomas's Hosp. Mus., B. 41.

Signs.—Certain characters are common to *all* dislocations of the elbow, a resemblance which renders it convenient to take these injuries consecutively, in regard to their signs, as showing more clearly their diagnosis.

Dislocation of the radius and ulna *backwards* presents a projection of the elbow *posteriorly*—corresponding to tho extremities of both bones, and of the olecranon in particular; with another projection, the end of the humerus in front of the elbow. (Fig. 359.) There is also some shortening of the forearm, with semi-flexion at an obtuse angle, or approaching to a right angle occasionally, and semi-pronation; with loss of the motions of flexion and extension, pronation and supination, but an unnatural lateral motion can generally be produced.

Fig. 359.*

Dislocation of the radius and ulna *outwards* is characterized by an unnatural projection *externally*—the head of the radius, with a prominent projection internally,—the inner condyle; while dislocation of the radius and ulna *inwards* is distinguished by the opposite characters—a projection *internally* of the olecranon, and prominence externally of the outer condyle.

The forearm is shortened laterally—on its inner aspect, by inclination to that side, in outward dislocation; and on its outer aspect, by inclination to that side, in inward dislocation—or the whole forearm is shortened longitudinally, in either of these dislocations upwards. In both, there is also semi-flexion, and semi-pronation. The speedy supervention of swelling, in these and other dislocations of the elbow-joint, will often render the nature of the injury more or less obscure.

Dislocation of the radius and ulna *forwards* would seem to be characterized by *disappearance* of the olecranon *posteriorly*, and the detection of this process and the head of the radius in front of the elbow; with shortening of the forearm upon the arm, semi-flexion to a right angle, and marked supination. If aecompanied with fracture of the olecranon, there will be some mobility and crepitus.

Disloeation of the *ulna* alone, *backwards*, would probably be recognized by projection of the olecranon, the head of the radius being felt to rotate in its place; by the inclination of the *forearm* to thc *ulnar side*, with partial flexion, and eomplete pronation. If accompanied with fracture of tho coronoid process, there will be considerable mobility, tho dislocation readily disappearing and recurring, with erepitus.

* Royal Free Hospital. (Author.)

Dislocation of the *radius* alone, *backwards*, is characterized by a projection of the head of the bone *behind* the outer condyle, where it can be felt to rotate; while dislocation *forwards* is distinguished by a projection of the head of the bone in *front* of the humerus. In *both* dislocations, the forearm is shortened slightly on its outer side, and inclines to *that side*, with slight flexion, and pronation. (Fig. 360.) But the latter form of dislocation is distinguished by the position of the head of the radius, and the impossibility of flexing the forearm beyond a right angle, where the head of the bone impinging on the front of the humerus brings this motion suddenly to a dead lock. This peculiarity was first shown me, when a student, by Mr. Morton, in a case many years since at the University College Hospital; and it was a well-marked sign in another case under my own observation and treatment at the Royal Free Hospital.

FIG. 360.*

Dislocation of the head of the radius, *outwards*, may be recognized chiefly by the position of the head on the outer side of the external condyle, immediately under the skin, where it can be felt to rotate.

Causes.—*Indirect* violence is, probably, more commonly the cause of all these dislocations. Thus, a fall on the hand may drive both bones backwards; possibly, outwards or inwards; the ulna alone backwards; or the radius alone backwards or forwards. But the position of the forearm, with regard to pronation or supination, will also affect the direction of the dislocation. The former position facilitates dislocation of the radius forwards; and a violent effort to supinate the forearm, while it is grasped and held firmly in a state of pronation, will occasion dislocation of the radius backwards. Twisting or wrenching of the forearm, as by machinery, may also occasion dislocation of both bones outwards or inwards; and less probably of either bone—the radius, in particular—backwards or forwards. The latter dislocation of this bone has been produced in children, by lifting the child suddenly from the floor by the hand, or an attempt to sustain the child when about to fall.

Direct violence may also be the cause of most forms of elbow-joint dislocation. Thus, both bones may be thrown backwards, by a blow upon the back and lower part of the humerus; or on the front and upper part of the forearm; or the bones are usually thrown outwards or inwards, by a blow on the side of the arm or forearm opposite to the direction of dislocation; and, in like manner, the radius alone has been started backwards, by a blow upon the front and upper part of that bone; or forwards, by a blow upon the back of the head of the radius.

Two dislocations of the elbow I have omitted to notice, in describing the etiology of these injuries. Dislocation of the radius and ulna *forwards* is, however, too rare an accident to be included in any general statement. In Velpeau's case, the man was knocked down by a carriage, the wheel passing over his right arm. Dislocation of the head of the radius, *outwards*—the other exceptional form of injury—is a

* After Liston.

modification of, or consecutive to, dislocation of that bone, forwards or backwards.

Age would certainly seem to have some predisposing influence relative, at least, to dislocation of the radius and ulna backwards. In fifty-six cases under Hamilton's observation, the average age was about twenty years, and twenty-two of the whole number occurred in children under the age of fourteen.

Unreduced elbow-joint dislocations are probably no exception to the pathological law of Dislocations in general: that the bones gradually adapt themselves to the particular displacement, forming a new articulation; with more or less recovery of the use of the limb. An unreduced dislocation of both bones backwards, and of seven years' duration, is depicted in Liston's "Surgery." The movements of the hand were considerably regained. The structural conditions acquired in such cases, as shown by dissection, have been noticed in some of the cases I have figured from original specimens. *Reduced* dislocations of the elbow generally result in a complete recovery of the use of the joint, within a few weeks. But in one of several exceptional cases under Hamilton's observation, a dislocation of both bones backwards was easily and promptly reduced in a lad eight years old; yet, six months afterwards, the arm had become bent to a right angle, and quite stiff at the joint. Four years later, the stiffness still continued, with only slight improvement.

Treatment.—Reduction of all the dislocations to which the elbow-joint is liable, can be effected by the same method—bending the elbow over the knee—but those of the radius are, perhaps, better accomplished in another way.

FIG. 361.

(1.) Bending the elbow over the *knee* was the method recommended by Sir A. Cooper. (Fig. 361.) The patient being seated on a low chair or stool, the Surgeon, resting one foot on the seat, places his knee in the bend of the dislocated joint; grasping the forearm, he presses the knee against the inner side of the forearm to unlock the ulna from behind the humerus, and drawing or bending the forearm round the knee, the bones readily come forward over the articular end of the humerus, into position. The action of the muscles will, in fact, effect reduction when the bones are dislodged. This result is announced by a sudden jerk of the bones slipping into place, with a restoration of the natural confirmation of the joint, which may, however, be less perceptible owing to the surrounding swelling; but the immediate mobility of the joint, so that the forearm can be bent upon the arm, even to a right angle, without pain, will be a further guarantee of reduction.

Another method, which seems to be a modification of the preceding,

was that recommended by Boyer. Extension is made from the wrist by one assistant, the forearm remaining at a right angle with the arm, while counter-extension is made by another assistant holding the arm; the Surgeon, grasping the elbow with both *hands*, presses the olecranon process downwards and forwards. This method does not so readily unlock the bones, and extension from the wrist tells more upon the radius than the ulna, which chiefly opposes reduction. It is, therefore, preferable to grasp the middle of the forearm with both hands, and draw it *forwards;* no assistant being required except, perhaps, to steady the arm. In either of these methods, it may be advisable to direct the arm backwards, so as to relax the triceps muscle. Liston, who recommended this position, at the same time made extension backwards, counter-extension being made from the shoulder.

(2.) Dislocations of the radius alone may be reduced by straight extension gradually from the wrist, the arm being fixed; aided by pressure on the head of the bone forwards or backwards, according to the dislocation. In backward dislocation also, forcible supination will aid in just throwing the head of the bone forwards over the articular surface of the humerus; while, in forward dislocation, forcible pronation will similarly jerk the head into place. But these movements are useless until the head lies on the brink of reduction, and unless while extension is still being continued. Skey applied this method of straight extension in dislocation of both bones backwards; but, according to my own experience, the ulna is thus less readily unlocked from behind the humerus.

After reduction has been effected, it should be maintained by the application of a right-angled split upon the back of the arm and forearm, with a compress over the head of the bone—in the case of radial dislocations; and the forearm supported in a sling. The period for removal of this retentive apparatus should be regulated by the liability to re-dislocation, and to stiffness of the joint.

Dislocation with *fracture*, as of the coronoid or olecranon process of the ulna, may be treated in the same way; but retention of the bone in position must be continued for some weeks.

Unreduced Dislocations of the Elbow are curable or incurable; partly according to their duration, principally however with reference to the form of dislocation. Recent dislocation of the ulna, or involving the ulna, is much more difficult of reduction than that of the radius after a long period; the difference being due to the irregular form of the head of the ulna, which opposes reduction. Dislocation of the radius alone has been reduced at *periods* varying from a few days to weeks or months. In one instance I reduced a dislocation backwards, of ten weeks' duration, and the patient, a laundress, recovered good use of her forearm. Dislocation of the radius forwards has remained unreduced in the hands of skilful Surgeons. Sir A. Cooper failed in two recent cases; and of the six which came under his immediate observation, only two were ever reduced. Malgaigne states that in a collection of 25 cases, efforts at reduction were ineffectual in 11, and the accident was unrecognized or neglected in 6; leaving only 8, of the whole number, reduced. The golden rule should be observed in elbow-joint dislocations, as in all other such injuries, not to interfere when the motions of the joint are tolerably efficient.

Compound Dislocations of the Elbow.—These injuries are always perilous; both on account of their nature, the size of the joint, and as

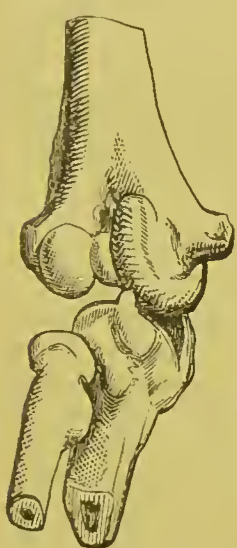
being caused by considerable violence. The "external latero-angular" dislocation, which I have described, was compound, and produced by a wrench of the forearm between the buffers of two railway carriages.

Treatment.—These compound injuries present nothing peculiar in relation to their treatment. The preservation of the limb, or operative interference, by excision or amputation, must be guided by similar considerations to those which relate to shoulder-joint dislocations, or to such injuries in general.

Congenital dislocations of the elbow have been met with, in the form of both bones backwards, or as pertaining to the head of the radius. These imperfections are more curious pathologically, than interesting surgically.

DISLOCATIONS OF THE RADIO-ULNAR ARTICULATIONS.—The head of the radius in its relation to the smaller sigmoid cavity of the ulna, constituting the *superior* radio-ulnar articulation, may undergo dislocation in the directions already described, as dislocations of the head of the radius,—backwards, forwards (Fig. 362), or outwards.

FIG. 362.*



The *lower end* or *head* of the ulna in its articulation with the lower end of the radius, is liable to dislocation, backwards or forwards.

FIG. 363.†

(1.) Dislocation *backwards* is characterized by an unnatural prominence of bone—the head of the ulna—at the posterior and inner part of the wrist, with loss of the motions of pronation and supination. In connection with *fracture* of the lower end of the radius, this dislocation is not very uncommon; alone, it seldom occurs, eleven or twelve cases only having been collected by Malgaigne; to which I may add one case from my own experience, the dislocation backwards being of four years' duration, and irreducible. (Fig. 363.)

The *cause* would seem to be, usually, violent pronation. Thus, Desault records the case of a laundress who, in wringing a wet sheet, produced dislocation of the head of the ulna backwards. But a fall on the hand, doubling the wrist forwards, was the occasion of this displacement in the case which came under my observation. The act of lifting a child by the hand gave rise to it, in a case which Duges mentions, and the accident happened in both wrists, at different times.

Treatment.—Reduction can be readily effected by forcible supination of the forearm, with pressure on the head of the ulna forwards. Generally the bone remains in place without further assistance; or it may be necessary to apply a compress and splint.

(2.) Dislocation *forwards* is denoted by a projection of the head of the ulna at the anterior and inner part of the wrist; the natural prominence of this portion of the bone at the back of the wrist having

* St. Bartholomew's Hosp. Mus., C. 37. † Royal Free Hospital.

disappeared. The motions of pronation and supination are lost. This dislocation is even more rare than the former; nine cases only having been collected by Malgaigne, to which Hamilton adds one more, as reported by Parker, of Liverpool.

The *cause* is apparently, with hardly any exception, violent supination of the forearm. And this mode of production throws light on the comparatively less frequent occurrence of this dislocation; the motion of supination being less extensive than that of pronation, and less likely to be excessive in any of the offices which the hand has to perform.

Treatment.—Reduction is easily effected by forcible pronation of the forearm, with pressure on the head of the ulna backwards.

Redislocation need not be apprehended. There was no such tendency in Mr. Parker's case.

Dislocation of the Radio-carpal Articulation, or Wrist-joint.—This articulation may undergo dislocation backwards, or forwards. Believed by Boyer, Petit, and the older Surgeons, to be a not uncommon form of injury, it is probable that most of the apparent cases of wrist-joint dislocation were fractures of the carpal end of the radius, and that Dupuytren's final experience is correct—this accident is extremely rare. In my own practice I have never met with it, nor have I ever yet seen any such dislocation; but undoubted instances have been recorded by Malgaigne, Cruveilhier, B. Cooper, Fergusson, and other Surgeons.

Fig. 364.*

(1.) Dislocation of the hand and carpus, *backwards*, presents a large projection—the carpus—at the back of the wrist (Fig. 364), and another—the lower end of the radius and ulna—on the palmar aspect; with flexure and immobility of the hand.

Fig. 365.†

(2.) Dislocation of the hand and carpus, *forwards*, presents just the opposite appearances: a projection of the carpus in front of the wrist (Fig. 365), and of the radius and ulna on the dorsal aspect, with extension and immobility of the hand.

Causes.—A fall on the hand is the usual occasion of dislocation; the back of the hand, probably, receiving the force of the shock in backward dislocation of the carpus, and the palm of the hand receiving the force in forward dislocation. These dislocations are usually said to arise conversely; but the cases described in Hamilton's work appear to clearly disprove the accepted representations in most surgical works.

Treatment.—Reduction can generally be effected, in either form of dislocation, by extension and counter-extension; at the same time drawing the hand in the contrary direction to which it is inclined,

* After Sir A. Cooper.

† St. Thomas's Hosp. Mus., B. 18. Dislocation of the hand and carpus forwards, *i.e.*, of the radius and ulna backwards. From a woman, aged 33. No history.

namely, backwards in the flexed position of backward dislocation, forwards in the more extended position of forward dislocation, and in either case aiding this leverage by pressing the carpus from behind, so as to bring it into place. Position should then be maintained by antero-posterior splints securing the hand, but allowing for the supervention of swelling.

INJURIES OF TE WRIST ALLIED TO DISLOCATION.—(1.) *Dislocation with fracture* of the lower end of the radius, happens far more commonly than dislocation alone. The diagnosis will turn on the presence of crepitus and mobility of the lower fragment, as determined by moving the hand, at the same time feeling whether the styloid processes of the radius and ulna move with it. Dislocation with fracture of the posterior margin of the articulating surface of the radius, is known as "Barton's fracture." Some difficulty may be experienced in keeping the bones in place.

(2.) *Fracture* of the lower end of the radius may be mistaken for dislocation of the wrist; but it can be distinguished in like manner. The comparative frequency of the former injury and rarity of the latter led Dupuytren to almost deny the possibility of radio-carpal dislocation; though the occurrence of this dislocation is now established beyond a doubt.

FIG. 366.*

(3.) Fracture with impaction of the fragments (Fig. 366) is unattended with the usual fracture signs, mobility and crepitus; but it may be distinguished from dislocation, chiefly, by the resistance offered to reduction.

(4.) *Sprain*, also, simulates dislocation: here, however, the swelling is single, and not well defined, like the bony projections of dislocation; it does not appear immediately, and gradually increases.

Compound Dislocation of the Wrist.—This accident is of rare occurrence. One case only has been seen by Hamilton, and one recorded by Sir. A. Cooper. As associated with fracture, the injury may happen more frequently. Always a serious injury, compound dislocation is even more so in consideration of the violence which causes it.

Treatment.—The amount of damage done to the soft textures and to the bones will guide the Surgeon respecting the probability of preserving the hand, or the necessity for *excision* or *amputation.*

Congenital dislocations of the wrist are described by Guérin as possibly occurring in three forms: forwards, backwards and upwards, backwards and outwards. These dislocations are connected with, and dependent on, imperfect conditions of the radio-carpal articulation, or incomplete paralysis of the muscles of the forearm and hand.

DISLOCATIONS OF THE CARPAL BONES, AMONG THEMSELVES.—Simple dislocations, or rather subluxations, of the carpal bones take place occasionally; but, perhaps, only in one direction—backwards. The bones thus liable to dislocation are the semilunar, cuneiform, and pisiform bones of the first row, and the os magnum of the second row, which is most frequently displaced, while, according to South, the unciform bone is also liable to displacement. All the bones of one row may be dislocated, the second row overlapping the first row,

* St. Bartholomew's Hosp. Mus., 3, 94.

backwards; as in a case which Maisonneuve verified by dissection. Dislocation of any of the carpal bones may occur, in connection with gunshot injury, or other occasions of extensive fracture of the neighbouring bones.

The *Signs* will be—a bony projection at the back of the wrist, with some loss of power.

The *Cause* is usually a fall on the back of the hand, which being thus forcibly doubled under itself, occasions one of the carpal bones to start backwards; the os magnum, for example. The pisiform bone is said to have been detached by the action of the flexor carpi-ulnaris muscle, in cases seen by Fergusson and Erichsen.

Treatment.—Pressure may easily replace the bone, but the application of a compress, and for some time, will be necessary, to guard against redislocation; the os magnum, in particular, having a great tendency to slip out again.

Dislocations of the Metacarpal Bones *at their Carpal Articulations.*—Any such dislocation is rare, and usually limited to a single metacarpal bone, *backwards.* The *thumb* is most commonly dislocated, and either *backwards* or *forwards* on the trapezium; the former displacement occurring more frequently. Either may be partial or complete. The other metacarpal bones are very seldom dislocated, Malgaigne having collected only three instances, to which a few others have been added. All the metacarpal bones, except that of the thumb, had undergone dislocation, in a probably unique case which Hamilton examined five years after the accident, by gunshot injury. The displacement backwards remained, but the motions of the fingers, except the fore and little fingers, were perfect.

The *Signs*, in any case, are sufficiently obvious: projection of the end, or *base*, of the metacarpal bone, in the direction of displacement, and immobility. The direction of the thumb may be quite straight, or with flexion there is also some inclination of the metacarpal bone inwards towards the palm.

Causes.—A fall on the thumb, bending it on itself, represents the ordinary mode of its dislocation. A blow upon the extremity and palmar aspect of the last phalanx may, however, cause dislocation; the force then acting in the opposite direction, or from within outwards.

Fig. 367.*

Treatment.—Extension, with pressure on the end of the bone, will generally succeed in effecting reduction. A splint should then be applied, and perhaps a compress to prevent any risk of redislocation. The bulky base of the metacarpal bone of the *thumb* sometimes obstinately resists reduction; in which case, Sir A. Cooper recommends that the dislocation should be left to acquire the compensatory motion of a new joint, rather than the Surgeon run any risk of injuring the nerves and blood-vessels, by dividing the muscles or ligaments.

Dislocations of the First Phalangeal Bones—*at their Metacarpo-Phalangeal Articulations.*—These dislocations, also, seldom happen; and usually the bone is driven *backwards*, though sometimes *forwards*. (Fig. 367.) I have seen the phalangeal bones of the index and middle fingers partly driven

* Guy's Hospital Mus., 1313.

back, in the left hand of a prizefighter. The first phalangeal bone of the *thumb* is most frequently dislocated, and either *backwards* or *forwards* (Fig. 368); the former displacement occurring more commonly. Hamilton has met with the backward dislocation nine times, the forward only twice.

Fig. 368.*

The *Signs* are characteristic: a projection of the posterior extremity of the phalangeal bone, in the direction of displacement, and immobility. The *thumb* presents somewhat peculiar appearances. Its first phalangeal bone, having slid backwards upon the metacarpal bone, stands off from this bone at an angle; thus allowing the *head* of the metacarpal bone to project prominently towards the palm of the hand; while the second or ungual phalangeal bone is flexed upon the first, and forms another angle in the thumb. The phalangeal bone is locked in its new position, and reduction may be proportionately difficult. This immediately arises either from the constriction of the neck of the bone between the lateral ligaments, as Hey believed; or between the two heads of the short flexor muscle, as affirmed by Malgaigne, Vidal (De Cassis), and others. Sir A. Cooper attributed the difficulty of reduction to the resistance offered by all the six muscles which are inserted into the two phalangeal bones of the thumb, the flexors more especially maintaining the displacement; or that the sesamoid bones oppose reduction; lastly, the difficulty may be due to the interposition of the anterior ligament, torn from its attachments and folded in between the joint, as alleged by Pailloux, Lawrie, and many others. Displacement of the long flexor tendon inwards or outwards, so as to impede reduction, has been found by Lisfranc, Deville, and Wadsworth.

Treatment.—Reduction can sometimes be accomplished easily; by extension, inclining the finger towards the palm, with pressure on the displaced end of bone. Or, the thumb may require more powerful traction; and by first bending the dislocated phalanx backwards, so as to increase the displacement, the articular end of the phalanx will be directed forwards towards the articular surface of the metacarpal bone, thus aiding the reduction. This preparatory movement was suggested by Roser, and it has since been generally adopted with advantage. Extension may then be accomplished by means of a strong tape fastened on the phalanx with a clove-hitch knot (Fig. 369), care being taken to protect the skin by a piece of moist wash-leather wrapped round the part. Or pulleys may be had recourse to, applied in like manner. A more effectual mode of extension, occasionally, is by means of a large door-key; which, I believe, Mr. Liston originally suggested.

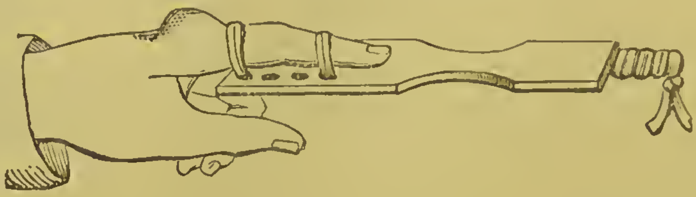
Fig. 369.†

* King's College Mus., 1344[2]. In this case, with dislocation of the first phalanx of the thumb forwards, there was also oblique fracture of the metacarpal bone. (John Wood.)

† After Liston.

Passing the ring of the key over the thumb, and hitching it against the projecting end of bone, extension and pressure can thus be brought to bear with advantage and simultaneously. Levis's extension-instrument (Fig. 370) enables the Surgeon to apply flexion or leverage also, in any direction. The Indian "puzzle," a cone formed of plaited ash-splittings, had long been used as an instrument of torture for the traction of a thumb or finger, but it was first employed by Hamilton

FIG. 370.



to make extension in the reduction of dislocation. The thumb, for example, being introduced into the open end of this cone, on drawing the opposite end, the greater the traction the tighter the hold becomes; yet the pressure is so equable and diffused over the whole surface, as to occasion little pain and no strangulation. When the traction is discontinued, the cone immediately loosens and relaxes its grasp. Before applying any extending force, reduction may be facilitated by soaking the thumb for some time in warm water, in order to relax the parts as much as possible; a very useful recommendation given by Sir A. Cooper.

Subcutaneous section of the opposing ligaments or tendons should be resorted to as the last resource. Originally proposed by Sir Charles Bell, it was employed successfully by Mr. Liston in a case of recent dislocation,—not an hour having elapsed, the patient an old man and very drunk; no resistance, apparently, to reduction existed, and very powerful force had been applied and persevered in without avail. At last, the external lateral ligament was divided by the point of a very narrow and fine bistoury; and then replacement became immediate and easy. Some inflammation followed, but was kept within bounds, and the man regained the use of the articulation. This method has since been practised successfully by Syme and Lizars, and by Reinhardt, also by Gibson, Parker, and other American Surgeons.

DISLOCATIONS OF THE MIDDLE AND UNGUAL PHALANGEAL BONES occur even less frequently than dislocations of the first row. Their pathology, signs (Fig. 371), and treatment are similar.

FIG. 371.*

Compound Dislocations of the Bones of the Hand.—Those of the *thumb* are most common, as they are also the most serious and important with regard to the future use of the hand. But any such dislocation is usually connected with fracture, and extensive laceration of the palm.

The *causes* of these injuries are always some occasion of extreme violence. The explosion of a flask of powder in the hand happens now and then, driving one or more of the bones backward, and otherwise shattering the hand. I have had to deal with two such accidents

Treatment.—*Reduction* can usually be effected without difficulty; the

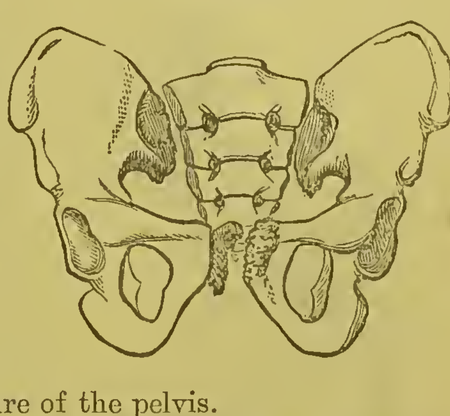
* St. Thomas's Hosp. Mus., B. 20. Dislocation forwards of the second phalanx of finger, consequent on disease of the joint.

obstacles of ligaments or tendons having already given way as part of the injury. The wound should then be closed, and the joint fixed, as in ordinary compound dislocations. Generally, however, the extent of injury requires some operative interference. *Excision* of splintered portions of bone, or *amputation* of one or more fingers, may therefore become unavoidable alternatives. The preservation of the thumb, and perhaps of the little finger with it, is always a consideration of paramount importance. This remnant hand will serve the useful purpose of a hook, or of prehension by the conjunction of the thumb and finger.

Congenital Dislocations of the Fingers.—The last three fingers of the left hand in a fœtus examined by Chaussier, were found to be dislocated at the metacarpo-phalangeal articulation. The thighs, knees, and feet were also dislocated. The last two phalanges of the fingers are, M. Bérard states, incurved backwards, occasionally, in newly born children of the female sex; and Malgaigne has himself seen a woman in whom, from birth, *all* the *phalangettes* were carried backwards to an angle of 135°, leaving the heads of the phalanges projecting forward under the skin.

Dislocations of the Pelvis.—(1.) The *Symphysis-pubis* and the *Sacro-iliac Articulations* may, severally, undergo separation and displacement. In one case, I found all three articulations completely separated, in a young man whose pelvis had been subjected to severe compression. The same triple injury had occurred in the specimen here represented. (Fig. 372.)

Fig. 372.*



The *Signs* of any pelvic disarticulation are sufficiently obvious: some deformity and mobility at the seat of injury.

The *cause* of disarticulation is always some extreme violence, and generally a compressing force.

Treatment.—The same as in fracture of the pelvis.

(2.) The *Coccyx* is more frequently bent or displaced than fractured. Such dislocation may be *forwards*, as the result of a fall; or *backwards*, in consequence of pressure by the head of the child during parturition.

Treatment.—The same as for fracture of the coccyx.

Dislocations of the Hip-joint.—This joint is subject to four principal dislocations, and to five anomalous dislocations; resulting from the freedom of the motion of the hip—as a ball-and-socket joint—in all directions. The number of *possible* dislocations may therefore be added to by increasing experience; any point in the circumference of a circle representing a direction in which dislocation of the hip might possibly occur, from the joint as a centre. Taking the four principal dislocations of the hip in their order of liability, they are as follow:—

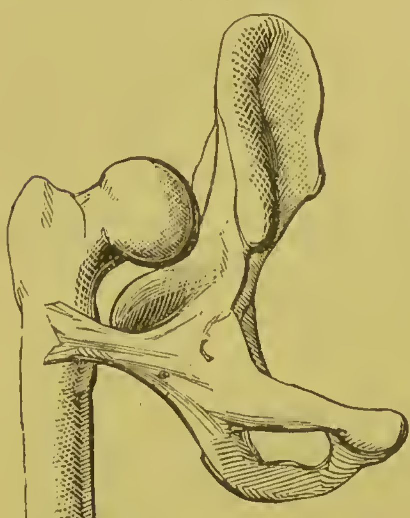
(1) Dislocation upwards and backwards on the *dorsum ilii;* (2) upwards and backwards into the great *ischiatic notch;* (3) downwards

* St. Bartholomew's Hosp. Mus., C. 42. Pelvis, showing separation of symphysis-pubis and sacro-iliac articulations, from violence, in a boy aged fourteen. The condyles of the femur were also detached at the line of epiphytic union.

and forwards into the *obturator foramen;* and (4) upwards and forwards upon the *pubes.* To these may be added, as anomalous and occasional dislocations—(5) Dislocation *directly upwards*, between the anterior superior and inferior spinous processes of the ilium, or thereabouts; *downwards* and *backwards*, upon the posterior part of the body of the ischium, between its tuberosity and its spine; (7) downwards and backwards, into the lesser or *lower* ischiatic notch; (8) directly or vertically downwards, beneath the lower border of the *acetabulum*, between it and the tuberosity—*subcotyloid;* (9) and forwards, into the *perineum*, upon the ramus of the ischium and pubis, or upon the body of the pubes. The four first-named dislocations severally require special consideration; but even their relative frequency is very different. Sir A. Cooper states that in 20 cases of hip-joint dislocation, 12 will be on the dorsum ilii, 5 into the ischiatic notch, 2 into the thyroid foramen, and 1 upon the pubic bone. This was about the proportion in Hamilton's larger collection of the same dislocations; of the whole number 104, the relative numbers were 55, 28, 13, 8. Chelius and Samuel Cooper reverse the order of liability in regard to thyroid and pubic dislocations, placing the latter before the former in frequency.

Dislocation upwards and backwards (1) on the Dorsum Ilii, and (2) into the great Ischiatic Notch.—*Structural Conditions.*—(1.) The head of the femur rests on the *Dorsum Ilii*, or within the fibres of the deeper gluteal muscles; and it is directed backwards, the great trochanter forwards. (Fig. 373.) The capsular ligament, and especially its posterior half, is lacerated, and the round ligament ruptured; the small external rotator muscles are stretched or rent completely asunder, and the glutæus maximus, medius, and minimus torn up more or less in extent from the dorsum ilii; thus allowing the head of the femur to occupy its unnatural situation. The triceps adductor is put upon the stretch. The particular direction of the head backwards and trochanter forwards, has been attributed to the strong anterior portion of the capsule which proceeds to the anterior inter-trochanteric line still remaining entire, and thus resisting the action of the rotator muscles. Resistance to reduction in this, and other dislocations of the hip, has been ascribed either to the rent capsular ligament entangling the head and neck of the bone; or to opposing muscles; or to both this ligament and the muscles.

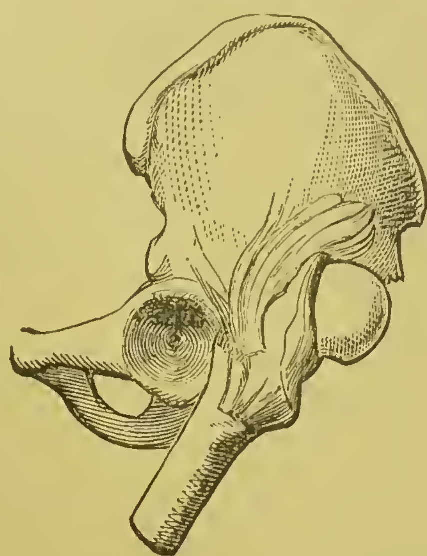
Fig. 373.*



* St. George's Hospital Museum, 1, 209. Dislocation of the femur on the dorsum ilii, with the remnant of the ilio-femoral ligament (inverted Y-shaped ligament, Bigelow), the shaft of the femur being placed vertically to bring the ligament fully into view. The dissection showed that the head of the bone was lodged just above the great sacro-sciatic foramen, the capsule having been ruptured so as to form a hole of sufficient size to transmit the head of the bone. The pyriformis muscle was partially lacerated; the other muscles were uninjured. This dislocation was caused by a fall from a height of fifty feet.

(2.) Dislocation into the great *Ischiatic Notch* corresponds so nearly in its pathology with that on the dorsum ilii, so to require only a *differential* description. The head of tho femur lies in the great sciatic notch, behind and a little above the acetabulum; being situated between the upper margin of the notch above, and the sacro-sciatic ligaments below. (Fig. 374.) It rests upon the pyriformis muscle; or upon the gemelli and sacro-sciatic nerve, as in a case dissected by Mr. Syme. The attitude of the bone, and rupture of the ligaments and muscles, are very similar to the condition of dorsal dislocation. With reference to the tendon of the obturator internus, the head of the femur passes downwards and backwards, and then being carried upwards, it is arrested by the tendon, or passes behind it. Hence, Bigelow names this dislocation "dorsal below the tendon." Ischiatic dislocation is sometimes secondary to that on the dorsum; but more frequently the former, by secondary displacement, is converted into the latter.

Fig. 374.*



Mechanism of Hip-joint Dislocation.—The production of the different forms of Hip-joint dislocation seems to depend, essentially, upon the integrity or the disruption of the *ilio-femoral* ligament, in the act of dislocation. It should be remembered that this ligament is that strong band which extends over the front of the capsule of the hip-joint, passing obliquely downwards between the anterior inferior spinous process of the ilium, and the anterior inter-trochanteric line bounding the neck of the femur. (See Fig. 373.) Thus attached at its extremities, the band is closely connected also to the forepart of the capsule, which it materially strengthens as an accessory ligament in front of the joint. When *not ruptured*, the resistance of this ligamentous band allows of displacement of the femoral head only in four directions, thus producing one or other of the four *regular* dislocations of the hip-joint; when *ruptured*, one or other of the *irregular* dislocations of this joint may be produced. With regard to the regular displacements; dorsal dislocation owes its inversion to the external fasciculus of the ilio-femoral ligament; in the ischiatic dislocation, the head of the femur is arrested in extension by the tendon of the obdurator internus muscle; in thyroid dislocation, the flexion and eversion of the limb are due to the ilio-femoral ligament; and in pubic dislocation, the ascent of the femoral head is arrested by this ligament. Dissections instituted by Dr. Fenner of New Orleans, Gunn of Michigan, Moore of Rochester, Busch of Bonn, and by Roser, Weber, Gellé, and Von Pitha, led the way to the more complete investigations by Dr. H. J. Bigelow, of Harvard University.

* St. Thomas's Hosp. Mus., B. 23[1]. Dislocation of the femur on the sacro-sciatic notch, or, rather, just behind the acetabulum. The pyriformis and glutæus minimus muscles are stretched over the head of the bone; the obturator internus, with tho torn gemellus muscles (not seen), lie immediately below. (Presented by Mr. MacCormac. See also "Reports of the Hospital," vol. ii. p. 1.)

Signs.—(1.) Dislocation on the *dorsum ilii* presents very characteristic appearances. The limb is shortened to an extent varying from one inch and a half as the average, to three inches occasionally; the knee is slightly flexed, and the thigh upon the abdomen, thus projecting the knee forwards; there is marked inversion of the limb, the knee being directed inwards, as well as forwards, towards the other, and just above it; the foot also is inverted, so that the great toe rests on the opposite ankle. (Fig. 375.) The head of the femur in its new situation, with the gluteal muscles, give an unnatural prominence to the posterior aspect of the buttock, and the bone can be felt, especially on rotating the limb; the prominence of the great trochanter is diminished and drawn upwards and turned forwards near the anterior superior spinous process of the ilium. Immobility of the limb, at least in the direction of eversion, abduction, and extension, will be more or less complete, and the patient has lost the power of such voluntary motion

Fig. 375.

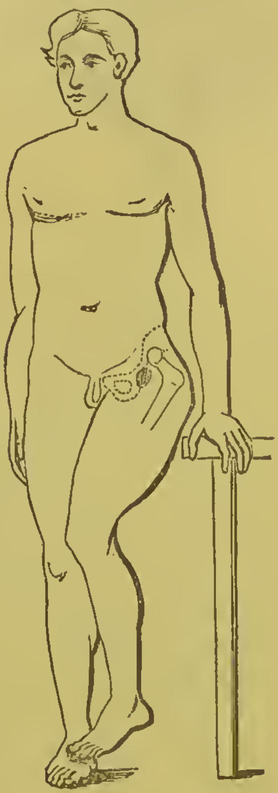


Fig. 376.

great pain also attends almost any movement of the limb. (2.) Dislocation into the great *sciatic notch* presents similar signs, but in a lesser degree; thus rendering the characteristic appearances less marked. Shortening has taken place to an extent usually of half an inch, and not exceeding an inch. Flexion and inversion are such, that the axis of the dislocated thigh points the knee less across the opposite thigh and the end of the great toe rests on the ball of the great toe opposite (Fig. 376.) The hip appearances are less conspicuous; the head of the femur sinking into the hollow of the notch, where, however, it can be felt in a thin subject, or by introducing the finger into the rectum or vagina, and the great trochanter approaches less nearly to the anterior

superior spinous process of the ilium than in dislocation upon the dorsum ilii. The lumbar spine is arched, when the limb lies in a line with the trunk, but when flexed upon the pelvis, the back rests flat upon the bed. This arched appearance, and its subsidence, is due to the tension or relaxation of the psoas and iliacus muscles. It is a most valuable sign, observes Mr. Syme, never being absent, nor is it ever met with in any other injury of the hip-joint, whether dislocation, fracture, or bruise.

The *diagnosis* of these dislocations from other injuries is, generally, clear. *Fracture* of the neck of the femur, accompanied with *inversion* of the limb, is comparatively rare; and when it occurs, mobility and crepitus of the fragments will, usually, determine the diagnosis. *Impacted* fracture, however, with consequently an absence of these signs, is always an equivocal condition. Two points of distinction between dislocation of the hip upwards and backwards, and impacted fracture, are laid down by Erichsen: that in dislocation, the head of the bone can be felt in its new situation by deep manipulation of the gluteal region; and that the trochanter is diagonal in its relative position to the anterior superior spinous process, whereas in fracture it lies nearly in a perpendicular line with it. Nélaton's "test line" affords a ready and accurate indication of any elevation of the great trochanter having taken place. It is a line drawn from the anterior superior spinous process of the ilium to the most prominent aspect of the tuberosity of the ischium. In the natural relation of the femur, whatever the attitude of the limb may be, this line coincides with the summit of the trochanter; but in either form of backward dislocation—dorsal or ischiatic—the trochanter rises above the line to half an inch or an inch higher. *Disease* of the hip-joint resembles dislocation upwards and backwards, in its general characters; and particularly when advanced to the stage of shortening the limb. The antecedent history of limping lameness and pain, before any such resemblance becomes established, will sufficiently decide the diagnosis. Failing to recognize the nature of the case, instances have occurred of attempted reduction in hip-joint disease; a sad mistake, and which would sorely aggravate the disease.

Causes.—The attitude of the limb at the time of dislocation is always most influential in this, as in other such injuries. When the body is bent forward on the thigh or the thigh on the abdomen, and the thigh in a state of adduction close to the opposite thigh;* hip-dislocation upwards and backwards may then result from a fall on the foot or knee, and especially while the individual is carrying a load on the back; or from the fall of a heavy weight, as a mass of earth, upon the back of the pelvis, the body being much bent forwards. Dislocation may thus take place either on the dorsum ilii, or into the great sciatic notch; but, to gain the latter situation, the limb must be in a position more nearly at a right angle with the trunk. *Age* has a remarkable relation to the frequency of hip-joint dislocation. Any such dislocation is comparatively rare in infancy and advanced life; but it has been known to occur in an infant, six months old, as the earliest time, and at eighty-five years of age, as the latest time. The period of life during which dislocations of the hip occur more commonly, has been stated, by Sir A. Cooper, as being from twenty to fifty years; by Malgaigne, as from twenty to forty-five years; and by

* The state of *abduction* may be the only causative position in *all* dislocations of the thigh. See "Med. Chir. Trans.," 1877. (H. Morris.)

Hamilton, as from fifteen to thirty, but that the next, and nearly equal, order of frequency is from thirty to forty-five years. These slight differences of statement are due to the different ages at which each series of cases commenced, and they tend to confirm the general result. *Males* are more liable than females to dislocation of the hip; owing to the more oblique direction of the neck in relation to the shaft of the femur, and also to the accidents, in the various occupations of the former sex, which cause dislocation.

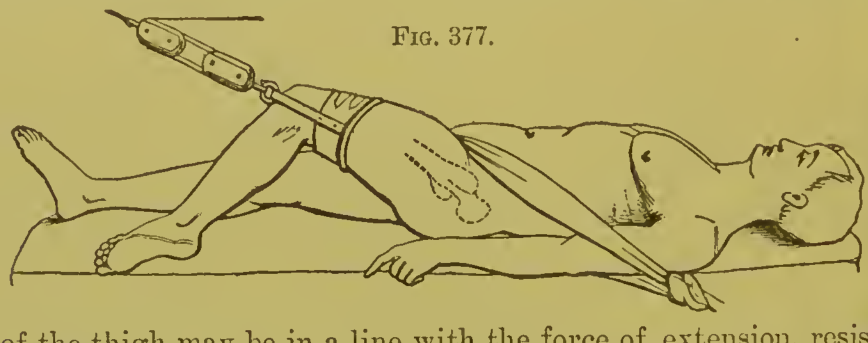
Unreduced dislocation of the hip backwards proceeds to the formation of a new joint; the pathology of which may be regarded as the type of any such compensatory construction, and is, therefore, considered in the general history of Dislocation.

Cases are on record showing the efficiency of the limb eventually, in a state of unreduced dislocation; one—related by Hamilton—after nine years' dislocation on the dorsum, where a young man could walk rapidly, although with a halt, yet without pain and discomfort; in another case, after only eight weeks' dislocation into the sciatic notch, the limb was quite useful. Reduction of dislocation on the dorsum is, generally, followed by speedy recovery of the use of the limb; in the course of a few weeks or months at most, the limb becoming as useful as before. The same may be said in favour of dislocation into the sciatic notch; reduction soon restores the thorough efficiency of the limb. But, after an unusual force or prolongation of extension, I have seen a permanent muscular weakness and limping lameness result; without, however, any recurrence of dislocation.

Treatment.—Chloroform should always be administered—unless specially contra-indicated—to relax the muscles. A warm bath may be substituted for the relaxing influence of chloroform, in exceptional cases. *Reduction* can then be effected in either of two ways: by extension and counter-extension of the limb, pulleys being necessary to overcome the muscular resistance and its duration, in most cases; or by flexing the limb on the thigh, and guiding it so into position, that the muscles themselves, probably, complete the reduction—constituting the method by "manipulation."

(1.) *Extension and Counter-Extension.*—The patient must be placed on his back, inclining to the side opposite to that of dislocation; and sufficiently raised from the ground on a bed or table, that the long

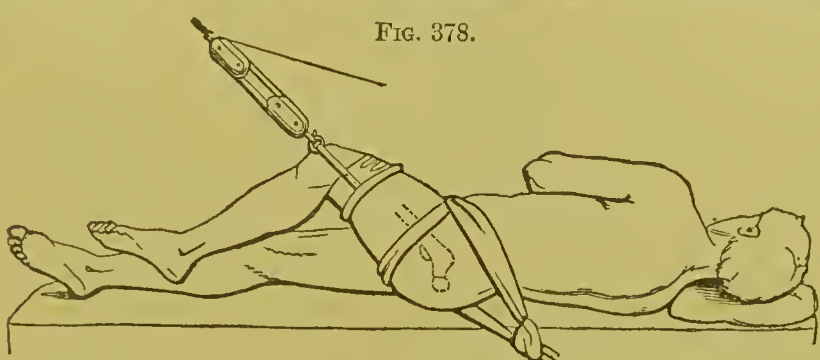
Fig. 377.



axis of the thigh may be in a line with the force of extension, resisted by counter-extension, which should be applied in the following manner. (Fig. 377.) A padded belt is fastened round the lower part of the thigh, having a double strap attached to it, terminating in a ring; to the latter a multiplying pair of *pulleys*, of three cords, is hooked, whereby extension is brought into operation; the distal pulley

being hooked to a ring or *staple* driven into the wall or some firmly fixed object, in a line with the thigh. A padded *perineal band*, for counter-extension, must be secured in like manner. An apparatus of this kind, and well adapted for the purpose, is manufactured by Messrs. Weiss. The cord of the pulleys may be intrusted to an assistant, the Surgeon taking charge of the thigh and hip. Extension should be made *slowly*, gradually increased, and steadily maintained. The great trochanter will be observed to descend, and to come more into position, as extension proceeds; the upper part of the thigh should then be raised with one hand or by means of a towel passed under the thigh, in order to lift the head of the femur over the prominent brim of the acetabulum; while, at the same time, the thigh is rotated outwards with the other hand, thus to incline the head of the bone downwards and forwards; it will, generally, be felt to slip in with a jerk, rather than a snap, the muscles being worn out beyond the power of any sudden contraction. On relaxing the extension, the perceptible disappearance of the signs of dislocation, in the length of the limb, etc., announces the certainty of reduction. The limb must then be retained in position, to guard against the liability of re-dislocation. A long splint and bandage, as for fracture of the thigh, has been recommended for this purpose; but simply connecting the reduced limb with the sound limb, by means of a few turns of a bandage around the thighs side by side, I have always found to afford a sufficient security. The patient must remain in bed for ten days or a fortnight, during the reparation of the ligamentous and other tissues.

FIG. 378.



Dislocation into the *sciatic notch* is reduced in like manner, but with greater difficulty, owing to the imbedded position of the head of the femur. (Fig. 378.) Extension should be made across the middle of the opposite thigh, and the head of the bone more lifted out of its bed; the patient inclining more to the opposite or sound side. To effectually raise the head of the bone, it is sometimes recommended that a towel, passed under the thigh, should be looped round the neck of an assistant, who, stooping over the pelvis and pressing downwards with both hands, raises his shoulders; thus bringing considerable power to bear in drawing the bone forwards towards its socket.

Jarvis's *adjuster* is applicable, instead of pulleys, for the purpose of extension. This instrument offers the advantages of completeness, in requiring no assistant, and no additional means for fixing the pelvis, while the limb can be moved in any direction during the extension. But the great power which can be brought to bear must not be overlooked, lest serious damage be done by any undue force. Although

a complicated apparatus—and, I may add, expensive—it may be specially serviceable in country practice, where the Surgeon is often unaided, or in the colonies.

Reduction by *rectangular flexion*, with *vertical extension—Bigelow's method*—is guided solely by the state of the ilio-femoral ligament. The thigh must be flexed to a right angle with the trunk, thus to relax this ligament; then the dislocation can be readily reduced by making extension directly upwards. Manual extension may suffice, or the pulleys can be applied, by means of a tripod placed over the limb, to the apex of which they are hooked. Or Jarvis's adjuster may be employed instead of pulleys. In either way, counter-extension is maintained by fixing the pelvis to the floor with a belt. Sometimes, there being only a slit in the capsule, which resists the return of the head of the femur into the acetabulum, it will be necessary to circumduct the limb, in order to tear the capsule open, before reduction can be effected.

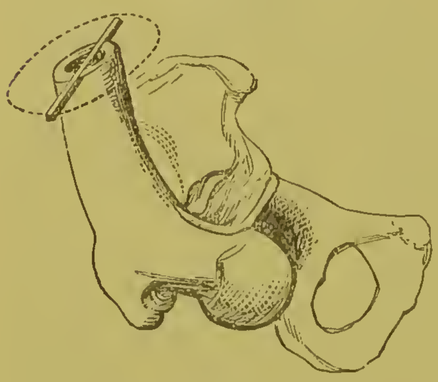
(2.) *Manipulation.*—This method of reduction was known to Hippocrates, and has since been variously practised by Surgeons in modern times, especially in 1815, by Dr. Nathan Smith, of New Haven; but, in 1851, Dr. W. W. Reid, of Rochester, N.Y., so attracted the attention of the profession to this proceedure, as to have fairly introduced it as an established method of practice.

Dr. Reid's method consists :—"In flexing the leg upon the thigh, carrying the thigh over the sound one, upwards over the pelvis as high as the umbilicus, and then abducting and rotating it outwards."

Hamilton's description of the proceeding is this :—"The patient being laid on his back upon a mattress, the Surgeon—assuming that it is a dislocation on the *dorsum ilii*—should seize the foot with one hand and the other he should place under the knee; then, flexing the leg upon the thigh, the knee is to be carefully lifted toward the face of the patient until it meets with some resistance; it must then be moved outwards and slightly rotated in the same direction until resistance is again encountered, when it must be gradually brought downwards again to the bed. We do not know that the whole process could be expressed in simpler or more intelligible terms, than to say that the limb should follow constantly its own inclination."

In attempting the reduction of dislocation into the *ischiatic notch*, by manipulation, the same author warns us of the special danger, "that the head of the bone will be thrown across into the foramen thyroideum."

Fig. 379.*



Bigelow's directions for manipulation are very similar :—To flex the thigh upon the abdomen, abduct and then rotate outwards (Fig. 379) ; or perhaps adduct and rotate slightly inwards to dislodge the femoral head from behind the acetabulum, then to abduct and extend directly upwards. Circumduction may be necessary to lacerate the capsule more entirely, before reduction can be accomplished.

"The following summary of a paper—prepared by Dr. Hamilton—

* After Bigelow.

with the view of determining, if possible, the relative value of the two methods—manipulation and extension—and exhibiting an analysis of 64 cases in which manipulation was employed, will enable the reader to form some estimate of the difficulty in which this subject is involved; and if it does not actually decide a moot point, it will at least demonstrate that the method by manipulation is not without its hazards. Of 41 cases in which the fact is stated, 28 were reduced on the first attempt, 7 on the second, 4 on the third, and 2 on the seventh. In 7 examples, the head of the femur has been thrown from one position to another upon the pelvis, travelling from the dorsum ilii to the ischiatic notch, and from thence to the foramen ovale; or directly from the dorsum to the foramen, and back again; or in other directions, according to the character of the original dislocation; in some instances these changes being made as often as seven times in succession. In the majority of cases, no evil consequences seem to have followed upon these changes of position."

Dislocation Downwards and Forwards into the Obturator Foramen.—*Structural Condition.*—The head of the femur lies in front of the obturator foramen, lodged upon the obturator externus muscle, the ball being directed inwards and the great trochanter outwards. The capsule has given way, especially on its inner side, and the round ligament is torn from its attachment; but the constancy of the latter lesion is disputed. In the case here represented (Fig. 380), the capsular ligament is extensively ruptured, and the round ligament torn from its pit in the head of the femur. This injury occurred in a man aged twenty-eight, deformed by rickets, who had thrown himself from a window sixty feet from the ground. The dislocation was reduced, but the case being complicated by a compound and comminuted fracture of the opposite thigh, death from shock ensued fifteen hours after the accident. The dislocation was then easily reproduced, so as to replace the parts in their original position. (See also "Trans. Path. Soc.," vol. ix. A. Shaw.)

Fig. 380.*

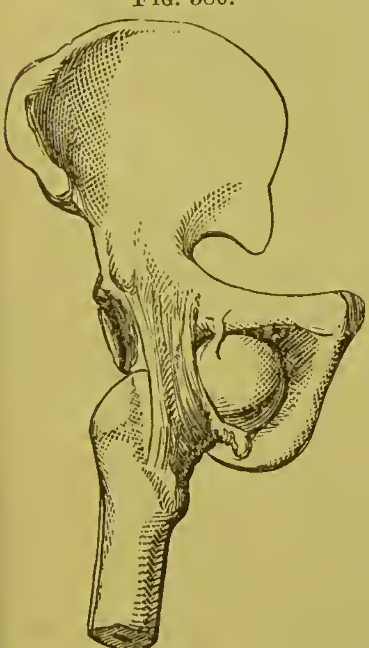


Fig. 381.

Signs.—This dislocation, also, presents very characteristic appearances. The limb is lengthened from one to two inches in extent, the knee bent, and the body inclined forwards—apparently to relax the painful tension of the psoas and iliacus muscles; and the whole limb

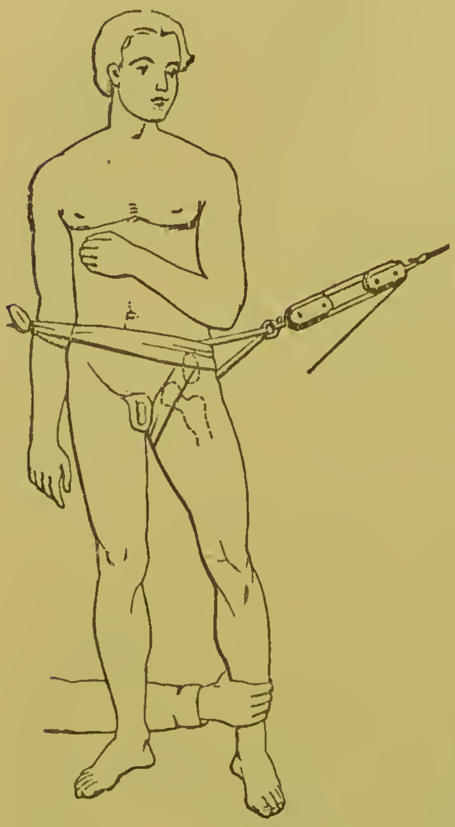
* Middlesex Hosp. Mus., S. iii. 13.

is in advance of the other, and much abducted; the foot usually points forwards, but occasionally it is slightly everted. (Fig. 381.) The head of the femur can be felt in its new situation, particularly in a thin person; and the prominence of the great trochanter has disappeared entirely, presenting a marked flattening of the hip, or a depression in the situation of the trochanter.

Causes.—The limb must be in a state of abduction at the moment of injury. Any force from below, or acting on the back, may then produce dislocation downwards and forwards, into the obturator foramen. Thus, a fall from a horse, with the thigh under the body of the animal, has had this effect; and Pirrie once found it caused by the person jumping in great haste out of bed, and while the left foot reached the floor, the right was entangled by the blankets in bed, thus separating the legs and thence producing dislocation into the obturator foramen. The fall of a heavy weight upon the back of the pelvis, when the body is bent forwards and the thighs are apart, will also produce the dislocation.

Treatment.—(1.) The patient is laid on his back. Extension must be made upwards and outwards by a perineal girth connected with the pulleys; and counter-extension maintained by another belt around the pelvis from the dislocated side. As the head of the bone is thus drawn towards its socket, the Surgeon, passing his hand behind the sound limb, grasps the ankle of the dislocated limb, and drawing it inwards and backwards towards the middle line, thus throws the head of the bone outwards and upwards to the acetabulum; observing not to flex the thigh, lest the head of the bone should start backwards into the ischiatic notch. The limb is here used as a long lever, over the resisting perineal girth, as a fulcrum. (Fig. 382.) This is Sir A. Cooper's method of reduction. Other methods have been devised, but they do not correspond more nearly to the direction of the displacement.

Fig. 382.



In the absence of pulleys, however, it is well to have other resources, as follow:—

(2.) Let the patient sit upon the front of the bed, astride one of the bed-posts, and grasp it; while extension of the limb is made by two assistants. Then, the Surgeon crossing the limb over the sound one, and rotating it outwards, may thus succeed in reducing the dislocation. This method was proposed and practised with success by Mr. Hey, of Leeds, in one case.

(3.) Manipulation seems to have succeeded in another case. Mr. Hey flexed the thigh to such an extent as to form an acute angle with the trunk, and then, by rotating it, accomplished reduction. Bigelow's

more precise directions are these:—"Flex the limb towards a perpendicular, and abduct it a little to disengage the head of the bone; then rotate the thigh strongly inwards, adducting and carrying the knee to the floor." (Fig. 383.)

DISLOCATION UPWARDS AND FORWARDS UPON THE PUBES.—*Structural Condition.*—The head of the femur rests on the anterior margin of the horizontal ramus of the pubic bone, with the great trochanter directed backwards. (Fig. 384.) Sometimes, the ball is driven up so

FIG. 383.*

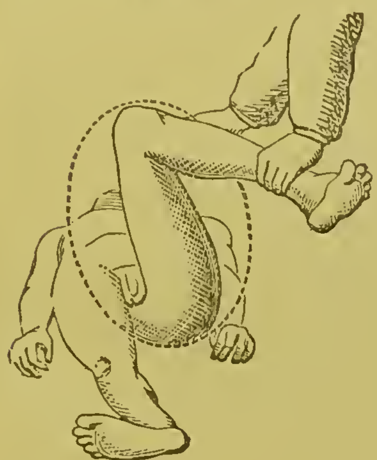
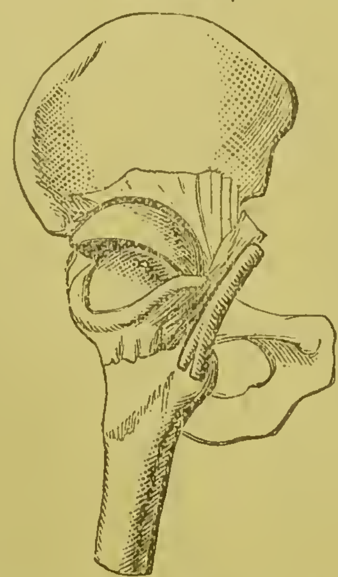


FIG. 384.†



high as to be hooked into the pelvis. The capsular and round ligaments are ruptured. In a case dissected by Sir A. Cooper, Poupart's ligament was torn, so as to allow the head and neck of the bone to pass underneath the iliacus internus and psoas muscles; the anterior crural nerve lying upon these muscles and stretched over the neck. The femoral vessels were to the inner side.

Signs.—The limb is shortened, generally to the extent of an inch; flexed slightly, decidedly abducted, and everted. (Fig. 385.) The globular head of the femur can be plainly felt on the pubic bone, to the outside of the femoral vessels, and made to roll under the fingers by rotating the limb; while the prominence of the great trochanter has disappeared, this portion of the bone being drawn inwards and upwards towards the anterior superior spinous process of the ilium. Immobility of the limb is a marked symptom, as regards rotation inwards;

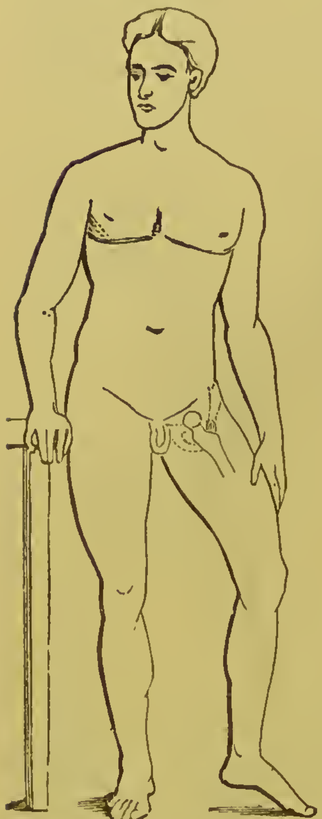
* After Bigelow.

† Roy. Coll. Surg. Mus., 881. Dislocation of the head of the femur on the outer part of the horizontal *ramus* of the *pubes*, in contact with the anterior inferior spine of the ilium; the posterior surface of the neck and great trochanter rested on the lower part of the ilium and the upper border of the acetabulum, extending backwards to the ischium. This dislocation had remained unreduced for many years before death. A new joint has formed, consisting of an adaptation of the surfaces of the ilium and os pubis to the upper part of the femur, and an elevation of new bone receives the neck of the femur. A strong capsule of ligamentous tissue is attached above to the ilium and os pubis, and encloses the head, neck, and trochanter of the femur. In this articulation, the head of the femur has lost its cartilage; but the surface became hardened, and has assumed a conical form. The acetabulum is obliterated by a dense ligamentous matter, occupying its cavity. (W. Lynn.)

and powerlessness equally so, with pain or numbness frequently, owing to pressure on the anterior crural nerve.

The *diagnosis* from *fracture of the neck* of the femur may be determined by the situation of the head of the bone and immobility, with crepitus in the case of fracture; or if the fracture be *impacted*, the head of the bone is still diagnostic.

Fig. 385.



Causes.—When the limb is directed backwards, and perhaps abducted, dislocation upon the pubes may occur; either by a fall on the foot, as when a person slides down from the end of a waggon; or when walking, the foot is suddenly planted into a hole, the pelvis advances, while the upper part of the body is thrown forcibly backwards, in order to avoid a fall. A severe blow on the back of the pelvis may have the same effect in producing dislocation upon the pubic bone.

Unreduced dislocation leads to the formation of a tolerably complete new joint. This result was found in the case examined by Sir A. Cooper. Upon the pubes a socket was formed for the neck of the femur, the head being above the level of the pubes. Both the latter portions of bone were flattened; the trochanter also was much altered in shape, and it partly occupied the acetabulum, which was otherwise filled with osseous deposit. This specimen is still in the Museum of St. Thomas's Hospital. The specimen I have figured is another illustration of a new joint.

Treatment.—(1.) The patient lying on his back, with the dislocated side near the edge of the bed, extension should be made from the lower part of the thigh, downwards and backwards, the pulleys being fixed accordingly; while counter-extension, by means of a perineal girth, is made in the opposite direction, over the body of the patient. (Fig. 386.) This force having, as usual, been

Fig. 386.

applied slowly, gradually increased, and steadily maintained, the head of the bone is lifted over the brim of the acetabulum by a towel under the upper part of the thigh, and the ball directed backwards by rotating the thigh inwards.

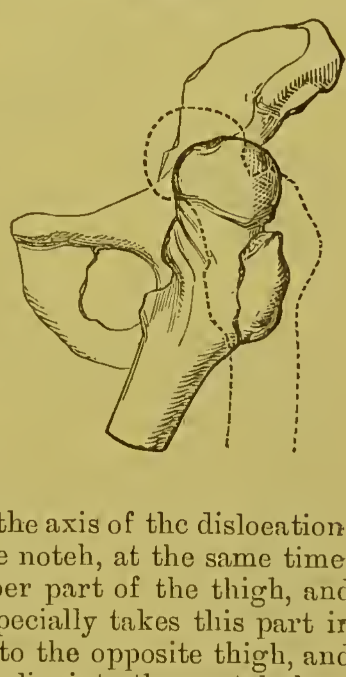
(2.) Manipulation may be employed, and according to various methods. Thus, Dr. Fountain, of Davenport, Iowa, succeeded in two cases, as follows:—The patient lying on the floor, and under the influence of chloroform, "the dislocated limb was seized by the foot and knee and rotated outwards, the leg flexed and carried over the opposite knee and thigh, the heel kept well up, and the knee pressed down. This motion was continued by carrying the thigh over the sound one as high as the upper part of the middle third, the foot being kept firmly elevated. Then the limb was carried directly upwards by elevating the knee, while the foot was held firm and steady, at the same time making gentle oscillations by the knee, when the head of the bone suddenly dropped into its socket." These manœuvres were executed with very little force, and occupied not longer than twenty or thirty seconds.

Anomalous Dislocations of the Hip-joint.—The hip-joint is liable to several irregular dislocations, the head of the femur being variously displaced upwards or downwards.

(1.) In dislocation *upwards*, the head of the bone may be displaced *directly* upwards, and be lodged between the anterior superior and anterior inferior spinous processes of the ilium—*supra-spinous* dislocation; or perhaps below the inferior spinous process, at the junction of the ilium with the pubic bone—*infra-spinous* dislocation; or the displacement may be upwards and slightly *backwards*, the head of the bone lying just behind the notch between the two anterior spinous processes—*anterior oblique* dislocation, so named from the oblique direction of the limb across the opposite thigh.

(*a.*) *Supra-spinous* dislocation was attended with the following signs, in a case related by Dr. Cummins ("Guy's Hosp. Rep." vol. iii.). It should be observed that the head of the femur—between the anterior spinous processes—is directed inwards towards the concavity of the ilium, the neck partly occupying the notch between the processes, and the great trochanter is turned backwards or everted. (Fig. 387.) Consequently, the limb is shortened by two or three inches, abducted and much everted, and so fixed in its position that rotation inwards is impossible and abduction and adduction are difficult, although a limited flexion on the pelvis can be performed. These movements cause great pain. The head of the bone may be felt as a globular tumour, beneath the anterior superior spinous process; but the trochanter has disappeared, and the hip is flattened.

Fig. 387.*



Reduction.—With extension by pulleys in the axis of the dislocation, the head of the bone must be lifted out of the notch, at the same time, by means of a broad bandage around the upper part of the thigh, and slung round the neck of the Surgeon, who specially takes this part in the reduction. Then by adducting the knee to the opposite thigh, and rotating inwards, the head of the bone may slip into the acetabulum. Or, reduction may be effected, as Bigelow observes, by a *manipulative*

* After Bigelow.

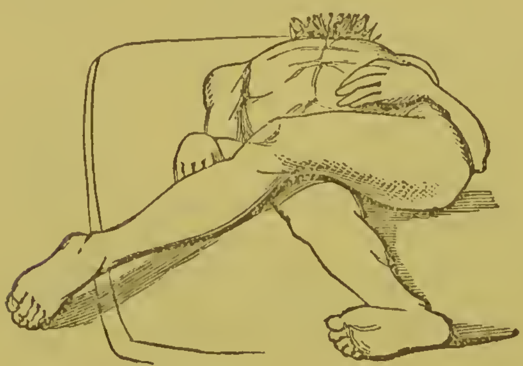
procedure, so as to convert the displacement into a dorsal dislocation. By "circumduction of the extended limb inwards, with eversion enough to disengage it from the edge of the pelvis," the head of the femur passes on to the dorsum; but if the outer branch of the Y ligament is broken, the limb does not become inverted. Reduction of the dorsal dislocation may then be accomplished in the usual manner. Of these two modes of reduction, the former seems the more simple, and should certainly be tried before resorting to the production of a second dislocation, in order to reduce the first.

(*b.*) *Infra*-spinous dislocation, beneath the inferior spinous process, is similar; but the shortening of the limb is less, and it is rather adducted, even so that the heel may rest on the instep of the opposite limb, although greatly everted. The head of the bone can be felt under Poupart's ligament, but there is marked flattening of the hip from absence of the trochanter, it being turned backwards into the acetabular cavity. This form of dislocation would seem to be a variety of the Pubic.

Reduction may be accomplished by extension of the limb, just to bring the head of the bone down opposite to the acetabulum, with forcible rotation inwards at the same time, to turn it into the cavity. Manual extension will be sufficient for this purpose, and then, by laying hold of the knee and foot, the limb can be used as a lever for the rotatory movement.

(*c.*) *Anterior oblique* dislocation is even more uncommon than the preceding forms of upward dislocation. The head of the femur resting on the ilium outside the notch between the two anterior spinous processes, the limb is shortened, as in supra-spinous dislocation, but it lies obliquely across the opposite thigh (Fig. 388), with some eversion, the great toe pointing outwards. This peculiar position of the limb may be produced by a modification of the ordinary dorsal dislocation. In the *reduction*, therefore, Bigelow directs that the limb should be brought across the symphysis pubis, with a little eversion, if necessary, to disengage the head of the bone; when, by inward rotation, the displacement will be converted into a dislocation on the dorsum ilii. This must then be reduced.

Fig. 388.*



(2.) *Downward* dislocation, in irregular directions, has been met with in three forms: downwards and *backwards*, upon the posterior part of the body of the ischium, between its tuberosity and its spine; or, into the *lesser* or lower ischiatic notch; *directly* or *vertically* downwards, beneath the lower border of the acetabulum, between it and the tuberosity of the ischium; or forwards, into the *perineum*, upon the ramus of the ischium and pubis, even as far as the body of the pubes.

(*a.*) Dislocation *downwards* and *backwards* upon the *tuberosity* of the ischium, or into the *lesser* ischiatic notch. This may be regarded as a

* After Bigelow.

variety of dislocation into the great ischiatic notch. But the attitude of the limb is peculiar. It is marked by great flexion and adduction, with inversion, so that the thigh lies across the opposite thigh (Fig. 389); and the head of the bone may be felt just above the tuberosity of the ischium, at the back part of the hip.

The *reduction* is most readily brought about by a *manipulative* procedure: flex the thigh to a right angle with the pelvis, abduct, rotate inwards, and then bring down the knee; thus, in fact, retracing the altered position of the limb.

(*b.*) *Vertically* downwards, beneath the acetabulum. Subcotyloid dislocation will also be recognized by the peculiar position of the limb; vertical flexion of the thigh to a right angle with the pelvis, and with-

Fig. 389.*

Fig. 390.*

out any notable adduction or abduction, inversion or eversion. (Fig. 390). This downward luxation may be considered as related to the typical form of thyroid dislocation. Two cases are recorded by Mr. Edwin Gurney (*Lancet*, 1845).

A similar mode of *manipulation* to that in the last case, will probably succeed in returning the head of the femur into the acetabulum.

(*c.*) *Forwards* and downwards, upon the ramus of the ischium, or into the perineum. Another form of thyroid dislocation, the attitude of the limb differs characteristically from that in the vertical dislocation. The thigh, somewhat flexed upon the pelvis, is in a state of extreme abduction and eversion; and the ball of the femur may be felt on the ischiatic ramus, or presents a tumour in the perineum. (Fig. 391.) An instance of this very rare form of luxation is recorded in the "Path. Trans. Lond." vol. x.

Fig. 391.*

Reduction may be performed, as in the case referred to, by extension of the thigh downwards from the pelvis, with traction from the

* After Bigelow.

perineum outwards, aided by the knee of the operator in the groin. But the *manipulative* procedure which is adapted for a regular thyroid dislocation, will here also prove successful.

Unreduced Dislocations of the Hip.—*Two months* was the period fixed by Sir A. Cooper, as the extreme period within which such dislocations can or should be reduced. Increasing in difficulty and danger, as the operation of reduction may be up to that time, it subsequently becomes extremely uncertain of accomplishment, and always perilous, owing to the liability of fracture or of abscess, from the straining injury to the soft textures. The former accident has occurred in the hands of some of the most able Surgeons; fracture taking place usually in the neck of the femur or not far below the trochanters. *Exceptional* cases of successful reduction after a much longer period have more recently been recorded. Thus, two cases are cited by Hamilton, both of *six months*' standing, and, it may be added, both dislocations on the dorsum ilii. At the end of *nine* months, Dr. A. W. Smith obtained a successful result, the patient having resumed his occupation as a ship-carpenter. In more rare instances, reduction has been accomplished—by Salicet, at the end of one year; by Liston, at the period of two years.

The physiological consideration which, as a *rule*, should here, as in regard to all Dislocations, guide the Surgeon is, the *degree* of *efficiency* of the new joint; as indicating the practicability and safety of attempting reduction, and its utility when accomplished. After trying prolonged extension, it has been proposed, as the last resource, to attempt reduction by subcutaneous division of the capsule, or rather of the ilio-femoral ligament, followed by renewed extension or by manipulation. This method failed, however, in the hands of Hamilton, the only case apparently on record.

Dislocation of the Hip, with Fracture of the Femur.—This complication is undoubtedly possible, but very uncommon. Reduction of the dislocation would appear to be still more rare. The *rule of practice*, however, should always be to attempt reduction at the time of the accident. This may be accomplished, under the influence of chloroform, simply by pressure on the head of the bone and with the requisite manipulation; or by first setting the fracture and securing it with lateral splints, in order to make use of the limb for extension in reducing the dislocation. Failing at the time of dislocation to effect reduction, union of the fracture must be allowed to take place, and then it should be again attempted. This resource proved successful in one case, a dislocation on the dorsum ilii, of five weeks' duration; Mr. Badley being the operator. In another case, a dislocation into the sciatic notch, reduction at the end of six weeks, as reported by Mr. Thornhill, appears to have been doubtful. It would seem that, probably, he refractured the bone; for the head of the femur is said to have resumed its place with a loud *crash*.

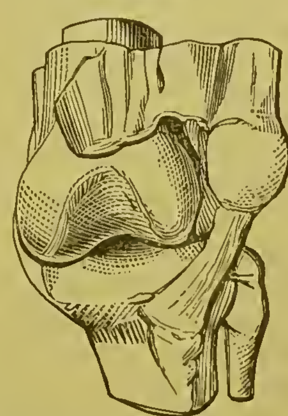
Double Dislocation, *i.e.*, of both hips, has been known to occur; and in different directions on the two sides, or with fracture of one femur.

Congenital Dislocations of the Hip-joint have been met with, complete or incomplete. The former correspond very nearly in their directions with the regular dislocations of the hip, and with one of the anomalous varieties—upward dislocation, in which the head of the femur is placed outside the notch between the anterior spinous processes of the ilium. These dislocations seem to be more frequent in females than in males,

and usually they are double. The causation of hip-joint dislocation, before birth, was attributed by Dupuytren to defective organization, and by Guérin and Carnochan to spasmodic muscular retraction; but it would appear that such dislocation is generally produced mechanically, taking place at birth, and in breech-presentation, by the traction-force applied to the thighs of the child in delivery. When arising from defective development, the joint consists of a stunted, small femoral head, and a misshapen, shallow acetabulum, provided perhaps with complete articular cartilages; but the round ligament is long, or wanting, and the capsule very large, loose, and incomplete. Congenital dislocation of the hip-joint, commonly on the dorsum ilii, is apt to be overlooked at birth, and may not be discovered until the child begins to walk, when the peculiar loose gait attracts attention. The displacement can even then be readily reduced, but it as easily returns. The movements are painless. Subcutaneous section of the trochanteric muscles overcame this difficulty in a case on which Mr. Brodhurst operated. But when the joint is imperfectly developed, the cure of congenital dislocation must be impossible. In fact, there is simply an incurable lameness. Yet, practically, it is highly important that this state should not be misunderstood, when met with either in childhood or in after life.

Dislocations of the Patella are liable to occur in four directions: (1) outwards more commonly, or (2) inwards; (3) vertically, the patella turning edgewise on its axis; or lastly, (4) upwards. Both the latter forms of dislocation are very rare.

Fig. 392.*



(1 and 2.) Dislocation laterally, *outwards* or *inwards*. The *structural conditions* in these two forms of Dislocation are analogous; the patella is displaced more or less completely in either direction, and rests on the outer side of the external condyle (Fig. 392), or the inner side of the internal condyle, of the femur.

Signs.—An unnatural swelling—the projection of the patella—can be seen and felt over the outer or inner condyle, with an unnatural depression in front of the knee, owing to the absence of the bone from its proper situation. The knee is much broader than usual, slightly bent, and immovable; considerable pain also is experienced, especially aggravated by any attempt to bend the joint.

Causes.—*Muscular contraction* of the quadriceps extensor would seem to be the usual cause of these dislocations. The *outward* displacement is particularly liable to occur in persons who are knock-kneed, or whose external condyles have not the usual degree of prominence anteriorly. Dislocation of the patella in this direction may sometimes be produced *voluntarily*. A dancing girl, who, from her earliest years, had habitually twisted herself into various attitudes, eventually became knock-kneed; and when the rectus muscle acted upon the patella, it was thrown nearly flat upon the side of the external condyle of the femur. Sir A. Cooper—who relates this case—also found the dislocation reproduced in another instance whenever the limb was extended, displacement arising from

* St. Bartholomew's Hosp. Mus., 3, 111.

distension of the joint with *synovial fluid*. *Indirect* violence is sometimes the cause; as a sudden twist of the thigh inwards, while the weight of the body resting on the foot, keeps the leg turned outwards; or a fall with the knee turned inwards, and the foot outwards. *Direct* violence, as a blow upon the inner or outward margin of the patella, may sometimes produce dislocation outwards or inwards, respectively.

These dislocations are very apt to recur.

Treatment.—Reduction is easily accomplished. But although perpetually recurring, or even remaining unreduced in a few cases, the use of the limb may be almost unimpaired. The patient lying on his back, the Surgeon raises the thigh towards the abdomen, so as to relax the quadriceps extensor muscle; and then by pressing the patella inwards, or outwards, over the condyle, it is at once drawn into place by the action of that muscle.

(3.) In *vertical* dislocation, the patella turns on its axis and presents edgewise. One margin looks forwards; the other rests and is fixed in the groove between the condyles. This twist may be more or less complete; whereby the margin of the bone looks obliquely forwards, or turns almost completely round so that the posterior surface of the bone partly becomes anterior. The latter displacement is very rare; and, indeed, any vertical dislocation is uncommon, not more than fifteen examples having been recorded.

Signs.—Vertical dislocation presents very characteristic appearances: the sharp projecting border of the patella can be clearly felt and seen under the skin, and the leg is forcibly extended, or sometimes flexed slightly.

The same *causes* may turn the bone vertically on its axis, which displace it laterally; and—as Hamilton states—an incomplete lateral may be converted into a vertical dislocation, if the bone hitches on one margin, and the extensor muscle contracts suddenly and violently, thus raising the other margin, or even completely turning the bone on itself.

Treatment.—*Reduction* can sometimes be managed with tolerable facility, or it may be extremely difficult, and sometimes impracticable, the margin of the patella being, it would appear, mechanically fixed in the intercondyloid fossa. The same method of reduction is applicable as for lateral dislocation: relaxation of the muscles by raising the thigh, and pressure on the patella, laterally on both margins, but in opposite directions. Or, forcible flexion of the knee, with rotation of the tibia on the femur, may succeed; forcible flexion and extension alternately has also proved successful, or a violent effort by the patient to make these movements. This failing, *subcutaneous section* of the tendon of quadriceps and of the ligamentum patellæ has been resorted to. But, in a case related by Mr. B. Cooper, from "Rust's Magazine," in his edition of Sir A. Cooper's work, this proceeding was more than unsuccessful; reduction was still impossible, and extensive suppuration followed, under which the patient sank and died.

(4.) Displacement *upwards* can only result from relaxation, or rupture, of the ligamentum patellæ; thus permitting the patella to glide upwards in front of the femur. I have seen this happen once, from forcible flexion of an anchylosed knee-joint.

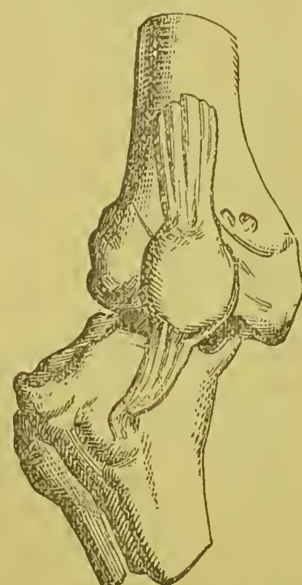
The *Signs* of such displacement are sufficiently obvious. The patella is drawn upwards, an interval appears below it, or a fold inwards when the leg is placed in an extended position; there is also marked mobility

of the leg and proportionate loss of extensor power, the leg hanging down nearly useless and swinging to and fro like a pendulum.

The *Treatment* is the same as for fractured patella or rupture of the quadriceps tendon. In the case referred to, the power of extension was but partially recovered.

Dislocations of the Knee.—This joint is seldom dislocated; nevertheless, the head of the tibia is liable to undergo dislocation in four principal directions, and in the following order of relative frequency: (1) inwards, (2) outwards, (3) forwards, (4) backwards. The first two dislocations are always incomplete, with one or two very rare exceptions; the latter two dislocations may be incomplete or complete. Velpeau has found on record thirteen examples of complete dislocation forwards, and eight backwards.

Fig. 393.*



Structural Conditions.—(1.) Dislocation of the tibia laterally, *outwards* (Fig. 393); the external condyle of the tibia rests upon the internal condyle of the femur, and the lateral ligaments are more or less completely ruptured. (2.) Dislocation laterally, *inwards;* the internal condyle of the tibia rests upon the external condyle of the femur, and the lateral ligaments are more or less entirely ruptured.

(3.) Dislocation of the head of the tibia, *forwards;* the head is situated partly, or entirely, in front of the condyles of the femur, according as the dislocation is incomplete or complete. The condyles of the femur project, proportionately, backwards in the popliteal space. (Fig. 394.)

Fig. 394.†

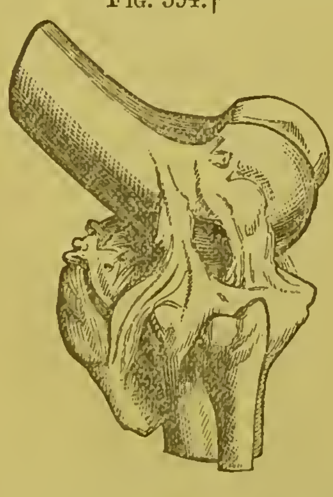
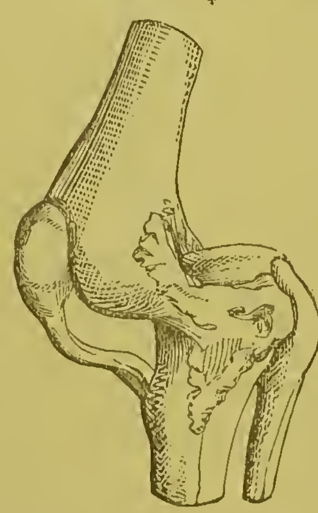


Fig. 395.‡



* Guy's Hosp. Mus., 1345^{50}. Dislocation of tibia outwards, resulting from disease of the knee-joint.

† Ibid. 1346^{10}.

‡ St. George's Hosp. Mus., 1, 209A. Dislocation of the tibia backwards. The posterior surfaces of the condyles of the femur are united to the anterior margins of the tuberosities of the tibia, by firm osseous anchylosis. No history of this case.

(4.) Dislocation of the head of the tibia, *backwards;* the head is situated partly upon the posterior half of the condyles of the femur, or it passes up and rests against the posterior aspect of their articular surfaces, according as the dislocation is incomplete or complete. The condyles of the femur project, proportionately, forwards. (Fig. 395.)

In both the latter dislocations, (3 and 4), it is probable that the ligaments and surrounding structures are similarly injured. Thus, in backward dislocation, the posterior ligament of the joint is torn, the muscles of the ham are stretched, and the popliteal vessels and nerves compressed. With *complete* dislocation, the crucial or inter-articular ligaments are also torn.

Signs.—(1.) Dislocation laterally, *inwards* or *outwards*, presents opposite appearances. In the one, an unnatural swelling—the inner condyle of the tibia—on the inner aspect of the knee; and another swelling—the external condyle of the femur—on its outer aspect. In the other dislocation or outwards, an unnatural swelling—the outer condyle of the tibia and head of the fibula—is found on the outer aspect of the knee; and another swelling—the internal condyle of the femur—on its inner aspect. In both forms of dislocation, the leg is slightly flexed, or sometimes extended, and inclined inwards or outwards, towards the side of dislocation, but *not* shortened in its long axis. Immobility, with inability to use the leg and severe pain, are present, as, more or less, in all dislocations. All these signs or symptoms were marked in two lateral dislocations; one of which occurred in my Hospital practice; the other, an outward dislocation, in the case of a lady, now intimately related to me, but who, at the time of the accident, many years since, was under the able care of Mr. Pitt, of Norwich. This case is recorded in the "American Journal of Medical Sciences," vol. xxxi.; and it is also noticed in Hamilton's work. Mr. Pitt's patient quite regained the use of her leg; similar dislocation again took place about a year afterwards, and was reduced in the act of carrying the patient upstairs, by her foot accidentally getting entangled in the bannister-rails; it happened again about three months subsequently, when the knee jerked into place spontaneously; and I am happy to say that, excepting a slight weakness of the knee, she now suffers no inconvenience.

(2.) Dislocation *forwards* or *backwards* also presents opposite appearances. In the one, a large swelling—the bulky head of the tibia—projecting in front of the knee, with a deep depression immediately above it and the patella; and another large swelling—the condyles of the femur—in the popliteal region. In the backward dislocation, a large swelling—the bulky head of the tibia—can be felt in the popliteal space; and another large swelling—the condyles of the femur—in front of the knee, with a deep depression below in the situation of the ligamentum patellæ. In both these forms of dislocation, the leg is flexed; in the one case, slightly back upon the thigh; in the other, extended or bent unnaturally forwards from the line of axis of the femur; shortening also is conspicuous, if either dislocation be *complete*, and varying in extent from one to two inches, or more. Severe pain, and swelling of the limb, may arise from compression of the popliteal nerves and vessels.

Causes.—*All* these dislocations of the knee usually arise in like manner. *Indirect* violence is, perhaps, the most frequent cause; as

when the foot is made fast in a hole, and the tibia twisted upon the femur by the body swinging around upon the knee; or by a fall from some height, or by the individual jumping from a carriage in motion. *Direct* violence is represented by a blow upon the upper end of the tibia, or upon the lower end of the femur. In one remarkable case, recurring dislocation backwards was produced, as it seemed to me, by *hydrops articuli.* The head of the tibia passed backwards whenever the patient, a woman, bore any weight on her foot and attempted to walk. Similar dislocation, or a tendency thereto, is not an uncommon result of disease of the knee-joint, with retraction of the leg, causing the end of the femur to project forwards in standing or walking.

Unreduced dislocation of the worst form, or backwards, may terminate in the recovery of a tolerably useful limb. Three such incomplete dislocations, backwards and unreduced, have been seen by Malgaigne, and neither of the persons thus affected were very greatly maimed in consequence. One walked with crutches after three or four days, and with a cane after about five weeks. Another did not leave his bed under one month, and it was nearly one year before he could lay aside his crutches; but both of these individuals were finally able to walk at least twelve leagues a day. In a similar case seen by Lassus, the patient was confined to bed two years, yet he finally recovered a tolerable use of his limb. Reduction, promptly effected, with sufficient rest of the limb, is followed by sound recovery or very little, if any, maiming ultimately. This issue may be hopefully anticipated even when dislocation has occurred repeatedly at distant intervals, as happened in Mr. Pitt's case; although in such cases the knee remains weak.

Treatment.—Reduction can be accomplished, in the same way, in each form of dislocation of the knee. Flexing the thigh towards the abdomen, and fixing it for counter-extension, extension is then applied to the leg, in the direction of the long axis of the displaced tibia; pressure being made, at the same time, on the ends of the bones in opposite directions, so as to overcome the displacement. Thus, pressure should be applied laterally, on the head of the tibia in particular, inwards or outwards, according to these forms of dislocation; and on the same bone, downwards and backwards, in forward dislocation; or downwards and forwards, in backward dislocation. Splints should be employed to fix the joint, and the appropriate measures also for subduing inflammatory swelling, which is often considerable. At the end of two, three, or four weeks, according to circumstances, passive motion may be used gently at intervals, and the joint allowed gradually to resume its functions.

Manipulation will perhaps succeed in effecting reduction, when the dislocation is incomplete and recent. The leg should be carried in whatever directions it moves most readily; or, this failing, forced flexion and extension may be tried, at the same time twisting the leg a little from side to side, with pressure upon the ends of bone in opposite directions, to bring about replacement.

Internal Derangement of the Knee-joint—so named by Hey, who first described it—or subluxation of the knee, sometimes so called. This accident is not uncommon.

The *structural condition* is, probably, a partial dislodgment of one of the semilunar cartilages, owing to a disruption of its ligamentous

connection with the margin of the condyle; the thick margin of the cartilage thus becoming interposed between the articulating surfaces of the opposed condyles of the femur and tibia; or, part of the cartilage slipping before or behind the condyle, the articular surfaces are brought into contact. An analogous condition, in relation to the symptoms thence arising, may also occur, by the interposition either of a fragment of one of the cartilages (Fig. 396), or of an hypertrophied portion of cartilage, or of a false cartilage—a new formation, moving about more or less freely within the joint.

Fig. 396.*

Symptoms and Causes.—Sudden inability to use the joint is felt, which becomes locked, while walking, or by striking the toe against something, or by tripping the foot. Intense and nauseating pain accompanies this sudden locking of the joint, and the person falls to the ground. Any slight twist of the leg, as in bed, by the mere weight of the bed-clothes hanging upon the toes, has been known to produce the same effect. In either case, the joint is slightly flexed, and the leg perhaps somewhat rotated. Considerable swelling of the knee rapidly supervenes, and the synovial capsule becomes distended with fluid; in short, subacute synovitis ensues from this injury.

It is very likely to recur, again and again; thus rendering the prognosis unfavourable.

Treatment.—This "internal derangement" disappears, in most cases, as easily as it was produced. Flexion, with sudden extension, and slight rotation of the leg, will generally overcome the difficulty, if indeed it should not suddenly right itself. Immediately, the motions of the joint become free and painless, so that the individual can walk about as if nothing had happened. But it is better to place the joint at rest for a while, to subdue any synovitis which may have supervened, and then support the knee for some time by means of a knee-cap, to guard against the liability of recurrence.

Compound Dislocation of the Knee-joint.—This injury must be regarded as the most perilous of its kind, but fortunately it is of rare occurrence.

Treatment.—An attempt to preserve the limb will scarcely ever prove successful; and, excepting in a few cases of more limited damage to the popliteal vessels, nerves, and the integuments, where excision may be sufficient, amputation is the only resource. The injunction originally given by Sir A. Cooper, to sacrifice the limb, will generally be unavoidable for the probable preservation of life.

Congenital Dislocations of the Knee.—The head of the tibia has been found, at birth, dislocated in various directions: forwards, backwards, inwards, outwards, inwards and backwards, outwards and backwards, and simply rotated inwards. The first-named dislocation is much the most frequent; and the majority of all these congenital dislocations were incomplete. Double dislocations have been found in some instances. Thus, both tibiæ were displaced backwards in an infant otherwise deformed, according to Chaussier's observations.

* Univ. Coll. Mus., 284.

Dislocations of the Head of the Fibula.—The upper end of the fibula may, occasionally, be dislocated *forwards* or *backwards*. Of the former dislocation, Malgaigne has collected three examples, unconnected with any other accident, and not apparently due to any abnormal condition of the ligaments. I have seen another, or fourth, such dislocation, which had remained unreduced. Of backward dislocation, Hamilton enumerates three cases on record.

The *Signs* of these dislocations are very palpable; the projecting head of the bone, immediately under the skin, forwards or backwards, cannot fail to be observed.

The *Cause* is almost necessarily direct violence, as a blow on the head of the fibula. But muscular action is said to have produced two, at least, of the three forward dislocations.

The consequence of any such dislocation may be a laxity of the joint, with mobility of the fibula backwards and forwards upon the tibia. This was the result in one of the backward dislocations recorded by Sanson.

Treatment.—Reduction having been effected by pressure, the head of the bone must be kept in place by a compress and bandage.

Dislocation of the Lower End of the Fibula.—The only instance of simple dislocation is related by Nélaton as having occurred in the practice of M. Gerdy. It was a *backward* dislocation, of thirty-nine days' duration, and caused by the wheel of a carriage passing obliquely across the leg so as to displace the outer malleolus, backwards. The bone was in almost direct contact with the outer margin of the tendo-Achillis; the outer face of the astragalus, abandoned by the fibula, could be plainly felt, and the position of the foot remained unaltered. The patient could walk pretty well, the bone was fixed, and reduction not attempted.

Dislocations of the Ankle-joint.—The astragalus in connection with the foot may be dislocated from the articular ends of the tibia and fibula, in four directions: (1) outwards, (2) inwards, (3) forwards, and (4) backwards. They may be termed dislocations of the foot in these directions. Most of these displacements are accompanied with fracture of the fibula, the tibia, or of both bones. The description of these several forms of dislocation will, I think, be simplified by regarding at least some of them, conversely, as relating to the tibia.

Fig. 397.*

Structural Conditions.—(1.) Dislocation *outwards.* The lower end of the tibia is displaced laterally inwards upon the astragalus; the outer portion of the articulating surface of the tibia resting upon the inner portion of the upper articulating surface of the astragalus, or it may slide completely off in the same direction. The foot is turned outwards—everted. The internal lateral ligament is ruptured, but not perhaps completely, or the inner malleolus may be broken, or both; the fibula, also, usually gives way two or three inches above its articulation with the astragalus. (Fig. 397.) Sometimes, in addition

* St. Bartholomew's Hosp. Mus., C. 69.

to these injuries, there is an oblique fracture of the tibia upwards and outwards from the articulating surface, breaking off that portion of the tibia which corresponds to the inferior tibio-fibular articulation; this fragment remaining connected with the outer malleolus, while the tibia carries inward with it the portion of the fibula above the fracture.

Commonly, the astragalus undergoes a lateral rotation inwards, whereby its outer and upper margin glides beneath the middle of the lower articulating surface of the tibia; thus presenting the outer or fibular surface of the astragalus obliquely upwards, while its inner and upper margin is carried downwards towards the end of the inner malleolus.

(2.) Dislocation *inwards*.—The lower ends of the tibia and of the fibula are displaced laterally outwards (Fig. 398), and perhaps completely, the articulating surface of the tibia entirely sliding off the upper surface of the astragalus. The inner malleolus is broken off the tibia, but remains attached to the tarsus by the internal lateral ligament; and the external lateral ligament is ruptured, or the outer malleolus may be broken off the fibula, thus making a fracture of both malleoli. The foot is turned inwards—inverted.

FIG. 398.*

FIG. 399.†

The astragalus may undergo rotation outwards, analogous to that in the outward dislocation; here, its inner or tibial malleolar surface looks obliquely upwards.

(3.) Dislocation *backwards*.—The lower end of the tibia is displaced forwards on the astragalus, resting partly on this bone and partly on the scaphoid bone (Fig. 399); or completely forward, the tibia then resting on the scaphoid and internal cuneiform bones. The foot, in front of the ankle, is shortened. In the latter or complete displacement, especially, the lateral ligaments are more or less completely ruptured; generally the fibula is fractured, but on a level with the articulation; sometimes the internal malleolus also, and, still more rarely, a fracture occurs through the posterior margin of the articular surface of the tibia.

(4.) Dislocation *forwards*.—This injury happens even more rarely than the preceding, but Malgaigne has collected five instances. The lower end of the tibia is displaced backwards on the astragalus, resting

* St. Thomas's Hosp. Mus., B. 25. Dislocation of the tibia outwards, with fracture of the inner malleolus and of the lower end of the fibula. Bony union of both fractures, and anchylosis of the tibia and fibula. (Sir A. Cooper.)

† Ibid. B. 26. Dislocation of the tibia forwards, with fracture of the inner malleolus and of the lower end of the fibula. Bony union of both fractures. (Sir A. Cooper.)

partly on this bone and partly on the os calcis, behind it. The foot, in front of the ankle, is elongated. Dr. R. W. Smith believes that this dislocation is never complete, so that the tibia shall lodge entirely on the os calcis. The lateral ligaments are ruptured, or one or both malleoli are broken.

Signs.—Dislocation laterally, outwards or inwards, presents opposite appearances. *Outward* dislocation is characterized by violent eversion of the foot, its inner margin being directed downwards; the inner malleolus projects prominently under the integuments, and there is a corresponding depression above the outer malleolus, in the situation of fracture of the fibula. Crepitus may here be detected, and the foot can be moved about pretty freely by the Surgeon, but with great pain. *Inward* dislocation is distinguished by inversion of the foot, its outer margin looking downwards; and the outer malleolus projects strongly under the skin.

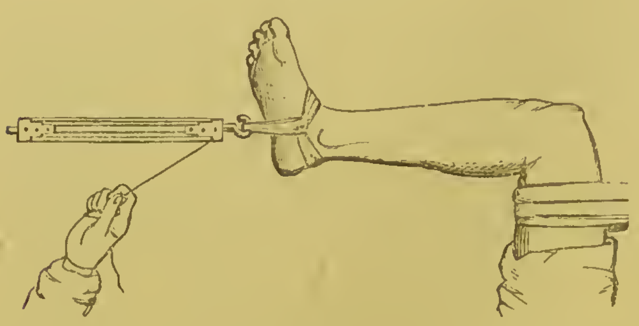
Dislocation backwards and forwards also present opposite appearances. *Backward* dislocation is attended with shortening of the foot in front of the tibia, and depression of the toes; while the heel is elongated, projecting posteriorly, and drawn upwards. The extensor tendons of the toes are sharply defined, and the tendo-Achillis is curved tensely forward. The foot is immovable. These signs are even more marked with *complete* dislocation; the end of the tibia can be distinctly felt projecting forwards, accompanied with an evident depression posteriorly in front of the tendo-Achillis. *Forward* dislocation is characterized by lengthening of the foot in front of the tibia, and elevation of the toes; with corresponding obliteration of the heel, which is in a line with the back of the leg, and depressed downwards. A portion of the articulating surface of the astragalus may be felt in front of the tibia.

Causes.—*Direct* violence, as a severe twist or wrench of the foot outwards or inwards, represents the ordinary mode of producing either lateral dislocation; the displacement taking place, obviously, in the *opposite* direction to such force. *Indirect* violence, as a fall from a height upon the bottom of the foot, may have a similar effect; if the foot have a sufficient inclination to either side, to thus direct the force of the impulse in favour of dislocation to *that* side. Forcible flexion or extension may produce dislocation backwards or forwards, respectively. A fall on the bottom of the foot, the body inclining backwards or forwards, tends also to produce dislocation in the *opposite* direction. But a person jumping out of a carriage in rapid motion, and alighting on his feet, is liable to dislocation *in* the direction of the momentum. Thus, from jumping out forwards, the dislocation will be forwards; from jumping out backwards, the dislocation will, probably, be backwards. When these two forms of dislocation are accompanied with fracture of the articular ends of the tibia and fibula, the displacement may be partly due to muscular action,—the contraction of the flexor muscles of the calf. Luxation may therefore occur at the time of the accident, or be consecutive to the fracture.

Treatment.—All these dislocations are reduced in like manner. The leg should be flexed to a right angle on the thigh, to relax the conjoined gastrocnemius and soleus muscles; extension is then made from the foot in a line with the long axis of the leg, taking care that the foot inclines midway between flexion and extension of the ankle-joint, and by drawing with one hand on the back of the foot and the other

hand on the heel, or making extension by means of pulleys. (Fig. 400.) Pressure on the head of the tibia, according to the direction of the displacement, will further aid reduction. In simply lateral rotation of the astragalus, with the foot turned outwards or inwards, the Surgeon will often succeed by grasping the foot with forcible adduction or abduction, thus to undo the displacement. After reduction in any case, lateral splints with foot-pieces may be applied; but I prefer a McIntyre's trough-splint, as affording a more equable support to the whole leg. The swelling around the joint is often considerable; it, however, subsides under the influence of rest and the usual topical applications.

Fig. 400.



Compound Dislocations of the ankle-joint are probably the most common of all compound Dislocations. Among the cases recorded by Sir A. Cooper, forty-five were dislocations of this joint; and among Hamilton's cases, four were dislocations inwards, and one a partial dislocation forwards. The displacements are the same, and arise from the same causes, as in simple dislocation of the ankle; but compound dislocation derives its importance from the size of this joint, and the violence of the injury.

Treatment.—Preservation of the foot—without any operative interference—proves successful in a far larger proportion of cases than in similar injury of the knee-joint. The wound should be closed and the leg kept at rest on a McIntyre splint. Protrusion of the tibia, with comminution, as often happens in backward dislocation, allows of *excision* in most cases. But severe contusion or laceration of the soft parts, including injury to the tibial arteries—in addition to compound dislocation of the joint—imperatively demands primary *amputation.* The usual consequences of inflammation, suppuration and sloughing, or gangrene, may render *secondary* amputation necessary, when an attempt to save the foot has failed.

Dislocations of the Astragalus.—This bone is sometimes displaced from under the tibia, and thrown—(1) *forwards*, (2) *inwards*, or (3) *outwards;* the two latter displacements probably being *inclinations* of the bone forwards in either of these directions, thus constituting two lateral dislocations; and occasionally it may be displaced (4) *backwards.* It may also be simply *rotated* on its lateral axis, without much, if any, lateral displacement; and, lastly, it is sometimes driven *upwards* between the tibia and fibula, tearing away the intermediate ligaments and generally fracturing one or both of these bones.

(1. 2. 3.) Dislocation *forwards*, and *inwards* or *outwards*, may be complete or incomplete. *Complete* dislocation of the astragalus represents its detachment from the os calcis and scaphoid bones, and its displacement from under the malleolar arch forwards; the bone lying upon the scaphoid and cuneiform bones. *Incomplete* dislocation signifies the separation of this bone from the scaphoid only, and the ejection of its

head on to the external cuneiform or cuboid bones; the body of the astragalus still retaining its connection with the os calcis and malleolar arch. (Fig. 401 and Fig. 402.)

Fig. 401.*

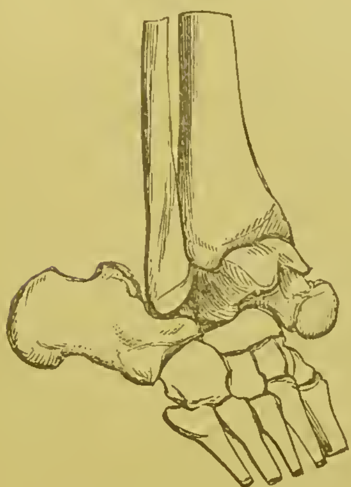


Fig. 402.†

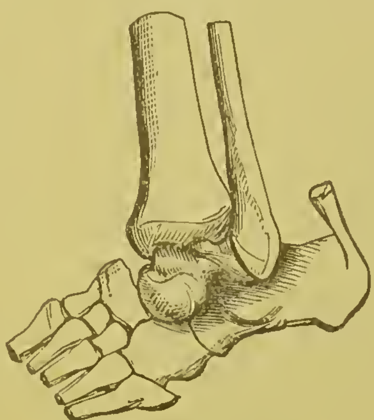
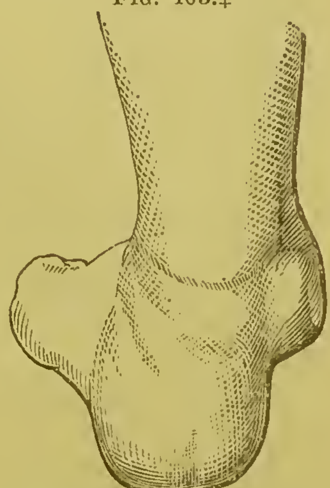


Fig. 403.‡



(4.) Dislocation *backwards* is a dislodgment of the astragalus on to the os calcis behind the tibia, in the interval between it and the tendo-Achillis. (Fig. 403.)

Signs.—The projection of the astragalus which can be felt and seen, in each of these directions of dislocation, is alone sufficient to indicate the nature of the injury. The malleoli are nearer the sole of the foot, the tibia having fallen down upon the os calcis; and there may be some flexion or extension of the foot.

The *Causes* of astragaloid dislocation resemble those of ankle-joint dislocation.

* St. George's Hosp. Mus., 1, 212. A disloeation of the astragalus *forwards* on the dorsum of the scaphoid bone. The deltoid and dorsal ligaments are ruptured. Many of the tendons round the ankle-joint were torn subeutaneously; and the integument having sloughed in a few days, the head of the astragalus protruded, thus rendering the disloeation eompound. Rigors followed, with pyamie infeetion. Amputation through the knee-joint and reeovery. This rare dislocation was produeed by a twist of the foot between two brieks, in deseending some steps.

† Ibid. 1, 213. Disloeation of the astragalus *outwards*, or "Disloeation of the os ealeis and seaphoid bones inwards from the astragalus." The ligaments of the ankle-joint were uninjured, exeept the anterior portion of the external lateral ligament. The interosseous ligament between the astragalus and os ealeis was partly ruptured. There is eversion of the foot, the solo being turned inwards. *Fracture* has taken plaee, a small portion of the astragalus being broken, and the eorresponding proeess of the os ealeis—sustentaeulum tali. These injuries were produeed by a fall from a height; and, on examination, the head of the astragalus was found projeeting at the outer edge of the foot, the sole being turned inwards; the tendo-Aehillis was very prominent, tense, and slightly eurved inwards. Reduetion eould be effeeted only by (subeutaneous) division of the tendon. For any further partieulars, see "Med.-Chir. Trans.," vol. xlii.

‡ Case by Dr. Hulme, of Dunedin. Exeision of astragalus. Reeovery, with free motion in ankle-joint.

Thus, a fall from a height upon the bottom of the foot, accompanied with violent abduction, adduction, and flexion; or extension, may determine a dislocation of the astragalus—forwards and inwards, or outwards; or backwards. A wrench or twist of the foot, in machinery or in the wheel of a carriage, for example, is another mode of production. A direct blow may also be the cause.

Unreduced dislocation of the astragalus is a not uncommon result, reduction being often very difficult and having proved impossible. The use of the foot has been recovered so far as to enable the person to walk again, but with considerable crippling.

Reduction, on the other hand, even when promptly and easily effected, has been followed by inflammation, and gangrene resulting in death.

TREATMENT.—Reduction—when practicable—can be accomplished in the same manner as in dislocations of the ankle. Flexion of the leg to a right angle with the thigh relaxes the muscles of the calf; and then extension from the foot, with counter-extension from the lower part of the thigh, aided by pressure on the displaced bone, will perhaps replace it. Division of the tendo-Achillis has facilitated replacement in obstinate cases. Thus, in a dislocation of the astragalus backwards on the calcaneum, the bone could not be reduced until the tendo-Achillis was divided, when I readily brought it forward into place.

The probability of effecting reduction depends very much on the dislocation being *incomplete; complete* dislodgment of the bone will be very difficult to overcome. The tibia and os calcis, powerfully drawn together, can hardly be separated to an extent sufficient for the return of the bulky astragalus; itself also bound down by the extensor tendons in forward dislocation, and by the tendo-Achillis in backward dislocation.

Should reduction have proved impossible, the integument over the projecting astragalus will probably slough and expose the bone; anticipating this result, it is better forthwith to proceed to *excision*, even if the dislocation be *simple.*

Compound Dislocation presents no peculiarity otherwise than the more serious nature of the injury, from exposure of the bone, and as occasioned by more severe violence. I have seen one such case,—a compound dislocation of the astragalus forwards and inwards on to the scaphoid bone.

Excision or amputation are the only alternatives. The results of the former operation have been so successful as to warrant its preference in general. Of eighteen cases, collected by Turner, wherein complete excision of the astragalus was performed, fourteen recovered, and with anchylosis in only one instance.

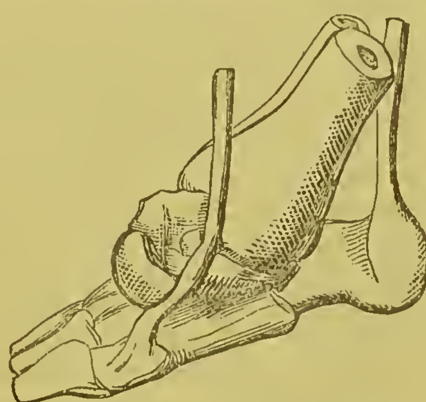
FIG. 404.*

DISLOCATIONS OF THE OTHER TARSAL BONES.—Such dislocations are very rare. The *Calcaneum* may, however, be dislocated *outwards* from the astragalus alone, or from the cuboid bone simultaneously, in a direction *outwards* and *upwards.* (Fig. 404.) The astragalus here remains connected with the scaphoid, and has sunk nearly an inch downwards below its natural level. The external malleolus seems to have passed behind the elevated articular surface of the os calcis, as if the dislocation had been produced in a forcible rotation of the foot inwards; the

* Roy. Coll. Surg. Mus., 884.

point of the malleolus rests on the inner and posterior margin of the tuberosity of the os calcis. The astragalus is fixed in its new position by osseous union to the adjoining inner and lower surfaces of the os calcis. The peronei tendons appear to have slipped from behind the external malleolus, and to have moved in a deeply grooved channel of new bone formed by the side and in front of the lower part of the fibula. (J. Howship.) Tho os calcis has also been found dislocated outwards from the astragalus and inwards upon the cuboid bone. But as verified by dissection, the following dislocation is worthy of notice :—"Dislocation of the *os calcis* and scaphoid bones *backwards* from the astragalus." (Fig. 405.) This bone is tilted up, so that its head projects above the other bones of the tarsus ; the posterior part of the bone is depressed, and the articular surface, removed from the os calcis, corresponds with the posterior articular surface of the scaphoid bone, in which position it was firmly fixed. There is partial *fracture* of the external malleolus of the fibula, the fragment remaining attached to the external lateral ligament connected with the os calcis. The deltoid ligament, on the inner side of the joint, still maintains the connection between the tibia and the astragalus. Theso injuries were caused by a fall on the foot in attempting to get out of a gig; and, on examination, the dislocation was obvious, with some slight bruising of the skin over the displaced bone. Reduction was impossible; diffused inflammation followed, with sloughing of the integument on the dorsum of the foot. Secondary amputation and death.

Fig. 405.*



The *deformity* in these dislocations is sufficiently characteristic to indicate the nature of the injury, in either case.

The *Scaphoid* and *Cuboid* bones, together, may be dislocated from the astragalus and calcaneum *upwards*—the middle tarsal dislocation of Malgaigne. The foot is shortened, and the instep raised; presenting the deformity of club-foot. This injury also has arisen from a fall, but on the ball of the foot.

The *cuboid* bone *alone* may, it is said, be dislocated upwards, inwards, and downwards ; but Malgaigne has found no case recorded of this displacement alone, unaccompanied with that of one or more of the other tarsal bones.

The *scaphoid* bone *alone* has been found dislocated from the cuneiform bones, its connection with tho astragalus remaining undisturbed. The dislocation was compound, yet — after reduction — the wound healed rapidly, and recovery soon became established.

Dislocation of the scaphoid from both the astragalus and cuneiform bones has occurred in several instances.

The *Cuneiform* bones may be partially dislocated, and without having separated from each other ; of which two or three examples aro recorded. The *internal* cuneiform bone alono has been displaced inwards. Sir A. Cooper saw two instances, in both of which the same

* St. Georgo's Hosp. Mus., 1, 212.

appearances were presented: great projection of the bone inwards, with some elevation by the action of the tibialis anticus muscle, and the bone no longer remained in a line with the metatarsal bone of the great toe. A fall from a height produced this dislocation in the one case; and in the other, a fall from a horse, the foot being caught between the horse and the kerb-stone. In neither case was the bone reduced; but the subject of the first of these accidents walked with only a little halting.

The *Treatment* of all these dislocations of the Tarsal bones is the same. Reduction may possibly be effected by pressure on the displaced bone. A compress and foot-splint will then be required to allow the bone to regain its ligamentous connections.

Compound dislocation of any of these tarsal bones may occur, but perhaps only from direct violence. Thus, compound dislocation of the calcaneum has been produced by the fall of a stone on the foot (South); and similar instances, with regard to the scaphoid and cuneiform bones, have been met with by Burnett and Aston Key. Reduction was accomplished in all these cases, followed by recovery with only slight lameness. Otherwise, excision or amputation must be resorted to, according to the amount of crushing injury.

Dislocation of the Metatarsal bones is also very rare. The metatarsal bone of the *great toe* has been dislocated upwards, an instance of which from direct violence was seen by Liston, and reduced. The *inner three* metatarsal bones were dislocated downwards and backwards, in a case recorded by Tufnell, and as resulting from a fall upon the leg by a horse rolling on its rider; Erichsen also found the *outer* three metatarsal bones dislocated downwards, by the pressure of a "turn-table" on a railway. Dislocation of *all* the bones backwards has occurred in the experience of Bouchard and Meynier; downwards, as Smyly relates; outwards, in a case which Laugier met with; and inwards, in a case seen by Kirk.

The *signs* of any single dislocation will be the particular deformity occasioned by the direction of displacement. When all the metatarsal bones are dislocated, say backwards, the dorsum of the foot is fore-shortened and presents a transverse ridge, while a corresponding depression appears on the plantar surface.

The *causes* are usually a fall backwards or forwards, the anterior extremity of the foot being wedged under some resisting body. Various crushing accidents also sometimes occasion these dislocations.

The *treatment* must be conducted on ordinary principles. Single dislocation can be reduced only with considerable difficulty, the bone not being accessible to extension, and it has remained unreduced in the hands of Malgaigne and other Surgeons. Multiple dislocation has proved far more easy of reduction. In each of the directions of displacement, involving all the metatarsal bones, it was readily accomplished by extension, combined with pressure suitably applied.

Dislocations of the Phalangeal bones of the toes resemble those of the fingers, and do not require a separate notice. In a case related by Sir A. Cooper, all the smaller toes were displaced backwards; a projection existed at their roots, and the extremity of the metatarsal bones bulged under the first phalanx of the corresponding toes. This displacement had been caused by a fall from a considerable height, upon the ends of the toes. Several months had elapsed, and reduction

could not be effected. Walking was rendered more tolerable by wearing a piece of hollow cork at the bottom of the inner part of the shoe, to prevent the pressure of the metatarsal bones upon the nerves and blood-vessels.

CONGENITAL DISLOCATIONS OF THE BONES OF THE FOOT.—These Injuries are associated with the various forms of Talipes or Club-foot.

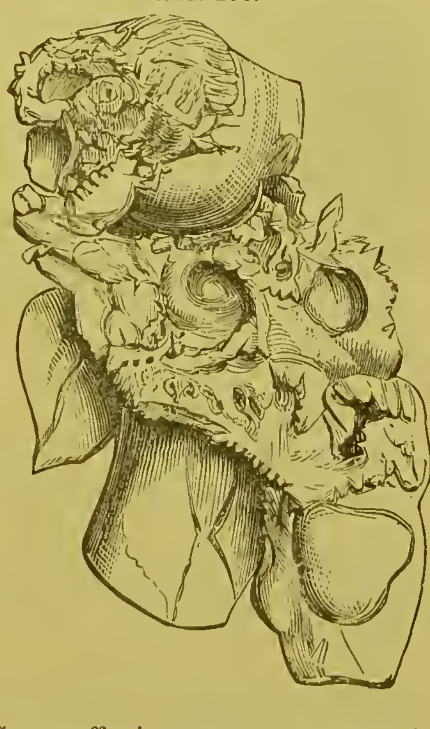
CHAPTER XXXVI.

DISEASES OF JOINTS.

UNLIKE Diseases of Bone—wherein the osseous texture or bone proper, the periosteum, and the medullary membrane or endosteum, are *less separately* and distinctly the seat of any particular morbid condition—Diseases of Joints relate to the synovial membrane, the articular ends of bone, and the articular cartilages, not to mention the ligaments, as, *severally*, the *seats* of disease; although any such morbid condition, isolated primarily, often spreads to the adjoining structures secondarily. Thus, the component structures of the joints have each an individuality in relation to Disease; and Diseases of the Joints have reference essentially to these component structures.

This pathologically analytical view of joint-diseases, with regard to their seat and origin in joint-structures, is due to Sir B. Brodie; prior to whose observations, both clinical and pathological, diseases of the joints were confounded under the ambiguous terms, "Arthritis" and "White Swelling."

FIG. 406.*



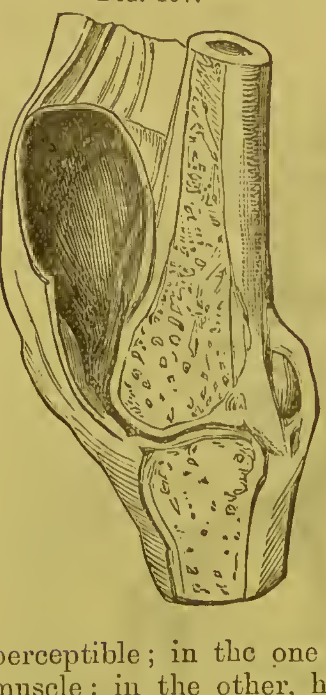
SYNOVITIS.—INFLAMMATION OF THE SYNOVIAL MEMBRANE. — *Structural Condition.*—An inflamed synovial membrane is more vascular than natural, in the form of crimson spots or diffused redness, and loses its glistening appearance. The synovial secretion is increased in quantity, and thinner or serous. These are the earliest changes. As inflammation proceeds, the membrane acquires a pulpy thickening and opacity, by interstitial exudation, and lymph is effused from its inner surface, giving it a granular or villous appearance (Fig. 406), and forming flakes in the synovial fluid, which also accumulates in quantity. Some effusion may even occur in

* St. Bartholomew's Hosp. Mus., 2, 3.

the sub-serous cellular tissue. This represents the *adhesive* stage of synovitis; an event, however, which rarely supervenes, as the opposed surfaces of the interior of the synovial capsule become yet more separated by its increasing distension. Subsequently, pus may be secreted within the capsule, which thus becomes converted into an *abscess*.

Signs.—Acute Synovitis.—The knee-joint may be taken for example, as it is more commonly affected than any other joint. Coincident with the earliest stage of inflammation, *pain* is experienced by the patient, and usually referred to a particular spot, perhaps the inner edge of the patella; afterwards extending over the whole articulation. The pain has no specially distinctive character. It is severe in proportion to the depth of the articulation and the unyielding nature of the ligamentous and other surrounding structures. It is also most intense in synovitis of a rheumatic or gouty origin, and as if the joint were compressed by a vice, or being violently torn open. In a period varying from two or three hours to as many days, according to the intensity of the inflammation, *swelling* makes its appearance. The consistence and shape of this synovial swelling are characteristic. At first fluid and fluctuating, it becomes semi-solid as lymph is effused, and again resumes its original fluidity in the event of serous collection, or of suppuration. But the shape of this swelling is even more remarkable. Throughout the course of synovitis, it corresponds to the shape of the synovial capsule; presenting that outline more clearly according to the degree of distension, and as modified by the compression of surrounding ligaments and tendons. The swelling, therefore, varies in form with each articulation, and its relation to the ligaments and tendons. Thus, in the knee, the swelling of synovitis is most conspicuous as a protrusion on either side of the ligamentum patellæ, betwixt it and the lateral ligaments, and rising up above the patella, bulges in a uniform shape as high as the distended capsule may extend. (Fig. 407.) At the same time, the patella is floated up from between the condyles, and when depressed with the finger, it rises again. In the elbow, the swelling projects on the posterior aspect of the joint, above the olecranon, and under the extensor muscles of the forearm. In the ankle, it presents on each side, between the lateral ligaments and the anterior tendons. In other joints less superficial, as the shoulder and hip, the swelling of synovitis is less perceptible; in the one being obscured by the cushion of the deltoid muscle; in the other, however, an evident fulness of the groin, and sometimes of the nates, can be detected. The wrist-joint is far less

Fig. 407.*



* Roy. Coll. Surg. Mus., 887. Synovial capsule of the knee-joint distended and thickened from chronic synovitis. A vertical section through the joint shows the height to which the capsule reaches—about four inches above the upper border of the patella, forming a sac between two and three inches in depth, and extending across the whole front of the thigh above the joint. (Hunter.)

frequently subject to synovitis; but here a general fulness and some bulging between the tendons—extensors and flexors—shows a conformity to the rule of characteristic swelling. Heat and, possibly, redness of the skin around the joint, will also be more or less evident; but these signs are not diagnostic. The attitude of the limb is more or less peculiar, or becomes so. The joint is placed in the position most easy to the patient, and usually becomes semi-flexed. Constitutional febrile disturbance, in some degree, accompanies these local symptoms.

Diagnosis.—Synovitis must be distinguished from hysterical affection of the joint; and this diagnosis well illustrates the differential characters of all local hysterical affections, as compared with disease of any part. *Arthritic hysteria* simulates synovitis; but the pain is most intense and disproportionate to any other symptom of disease; it is also superficial, or cutaneous, rather than affecting deeper textures, and diffused. Thus, the pain is elicited by touching, lightly handling, or bending the joint, but not provoked by pressing or concussing the heel upwards, so as to bring the articular ends suddenly into contact; and this surface-pain often extends upwards on the thigh, and down the leg to the foot. Spasmodic pains in the muscles are also experienced, rather than concussive startings of the limb, as when ulceration of the articular cartilages has taken place. All pain may cease at times, and recur; or it migrates suddenly, and settles in some other part; and then the simulated disease vanishes. The variations of colour and temperature are also significant; the limb being perhaps pale or of a purplish hue, and cold, in the morning, and becoming warm or hot to the touch, with a reddish, shining skin, in the evening. A slight puffy swelling may supervene on the intense pain, and as this puffiness corresponds to the margins of the articular cartilages, on either side of the patella, it looks as if the joint were affected. Generally, the limb is quite extended. While, therefore, the contour of the joint possibly resembles that of *articular* disease, the attitude of the limb usually differs from the semi-flexed position in that condition. The globular enlargement of the joint, with a half-bent relaxation of the limb, in *carious* disease of the articular *ends* of bone, would also sufficiently distinguish that condition. But the peculiarities of hysteric pain—in its severity, its superficial, diffused, and fitful character, with the changes of colour and temperature in the part—are altogether unlike the symptoms of any joint-disease, whether affecting the cartilages or the bones. Add to which, the constitutional health remains unimpaired, as by the symptomatic fever of inflammation, or the hectic of prolonged suppuration, in the early and advanced stages of joint-disease; and this difference of constitutional condition becomes more significant in its relation to the extent of the presumed disease and its duration. Chloroform lends invaluable aid in determining the diagnosis; under its influence, pain and functional disturbance being subdued, the presence or absence of structural disease can be more conclusively ascertained. The knee and hip joints are most frequently visited by hysteria.

Causes.—Exposure to cold, or some occasion of injury, as a blow or fall, sprain or wound, may give rise to acute synovitis. The disease thus occurs in joints which are most superficial and exposed, as the knee or elbow, sometimes the ankle or hip, occasionally the wrist or shoulder joint. But these causes are usually backed by some predis-

posing constitutional condition; especially rheumatism, scrofula, constitutional syphilis, or formerly, by the poisonous administration of mercury. Several joints may then be affected simultaneously. Inflammation of the synovial membranes also ensues, occasionally, from gonorrhœa or purulent ophthalmia. Such synovitis has been incorrectly named "gonorrhœal rheumatism," although not apparently depending on a rheumatic condition. Gonorrhœal synovitis would be a more correct designation. Arising after gonorrhœa of a few weeks' duration, from sudden arrest of the discharge, or after exposure to cold, it affects one or more joints—commonly the knee, and often both knees. Serum rather than lymph is effused into the joint, and the disease terminates without disorganization in a few weeks. Or it proceeds, sometimes, to ulceration of the cartilages, and continues for months or a year or two. In one such case, under my care, the knee-joint became firmly anchylosed.

Pyæmia induces a low inflammation of the joints, the special character of which is its abundant sero-purulent effusion, and consequent swelling; unattended by pain, heat, and redness, the ordinary symptoms of inflammation. Ulceration of the cartilages ensues if the patient lives long enough.

Terminations.—(1.) *Resolution* generally occurs; the pain, swelling, and other symptoms subsiding, and the joint regaining apparently a healthy condition. (2.) *Adhesion*, or complete fibrous anchylosis, sometimes results; the fluid or serous portion of the effusion being absorbed, the surfaces of the synovial membrane come together and are partially united by fibrous adhesions; thus leaving the joint much stiffened, in the state of *fibrous anchylosis.* (3.) *Fluid* remaining in the synovial capsule; the swelling becomes persistent, with laxity and weakness of the joint; constituting *chronic* synovitis. An extreme degree of this condition has been named *hydrarthrosis* or *hydrops articuli* —dropsy of the joint. Some lingering vascularity and redness, with thickening of the synovial membrane, remains. The knee-joint is most commonly affected; rarely the hip, shoulder, or elbow. (4.) *Suppuration* and *abscess* having occurred, the joint is distended with thick, opaque, yellow pus; the synovial membrane, very red and pulpy, is ulcerated in parts, and overspread with fibrinous purulent flakes; the articular cartilages undergo ulcerative disintegration into a whitish pulp, here and there, or the cartilage readily peels off; and the subjacent bone is very vascular, and liable to become carious—thus ending in total disorganization of the joint; or anchylosis supervenes —sometimes fibrous and stiffly movable, sometimes bony and fixed. The head of the femur and acetabulum, for example, both denuded of cartilage, may be found in a state of anchylosis—fibrous, or even osseous. Or, an articular abscess opens, attended with a temporary relief of the symptoms; but a wasting discharge ensues, and the inflammatory fever is exchanged for hectic, under which the patient would ultimately sink from exhaustion, unless the disorganized joint has been removed in time. *Periarticular* abscesses may form; either in the synovial bursæ adjacent to the joint, or in the subcutaneous cellular tissue, then having more the character of a diffuse suppuration. Thus, when the knee-joint is affected with acute purulent synovitis, the bursa under the ligamentum patella—or tendon of the quadriceps muscle—or the bursa in the popliteal space, may

suppurate in the form of an abscess; while, in the subcutaneous cellular tissue, suppuration may extend up the thigh and down the leg. These periarticular abscesses, therefore, occur independently of, although consequent on, the purulent synovitis; but they may subsequently communicate with the joint, especially the bursal abscesses. Hence, according to the nature of the fluid in the bursæ, puncture of the joint might yield pus in one situation, serum only in another part.* Purulent synovitis may be *acute* or *chronic*, according to the severity and duration of the symptoms; as depending chiefly on local or constitutional causes, *e.g.*, injury or scrofula.

Treatment.—Absolute *rest* of the joint should be observed, as primarily important; the limb being placed in that *position* which is most easy to the patient, and most convenient in the event of any stiffness remaining. A somewhat flexed position will, generally, best answer this twofold purpose. The limb may be sufficiently steadied by laying it on a soft pillow, which thus partially envelops the joint; or a suitable splint should be applied to insure rest. Local depletion by leeches, followed by warm fomentations, or cold lotions or irrigation will be appropriate, according to the intensity of the inflammation. *Constitutional* treatment has reference to the inflammatory fever, and any constitutional cause of the inflammation. Hence, saline antimonials, with perhaps calomel and opium, may be sufficient to subdue the febrile disturbance and check effusion; or the special treatment for rheumatism, constitutional syphilis, or other such causative condition, may be requisite.

Gonorrhœal synovitis is amenable to the same treatment as that arising from rheumatism. Thus, colchicum and iodide of potassium sometimes prove remedial. But the disease, in most cases, runs its course; or a change of climate from a cold and damp atmosphere to the southern coast, may be followed by a speedy subsidence of the symptoms.

By this plan of treatment, synovitis, in an early stage, will probably terminate by resolution or slight effusion.

Chronic synovitis must be treated with a view to the removal of the accumulated effusion, and consequent weakness of the joint. Counter-irritation in the form of blisters should be employed to overcome any persistent inflammation; followed by stimulating embrocations, and pressure to promote absorption. Two or three blisters in succession are certainly preferable to a single blister kept open with savine ointment. The discharge produced by savine ointment soon ceases, and the surface of the skin acquires a mammillated appearance from enlargement of its papillæ. The blisters should not be applied directly over the inflamed joint, but in the neighbourhood. Thus, in the case of the knee, a blister applied on either side of the thigh just above the joint; and with regard to the hip, a blister may be placed on the groin or nates. Of stimulating embrocations, a liniment of turpentine and olive oil, or the iodine paint, are perhaps most efficacious. Pressure can be applied by means of a gutta-percha or pasteboard splint, moulded to the joint; or the joint may be strapped with soap-plaster spread upon leather. The *emplastrum ammoniaci cum hydrargyro* conveniently combines both stimulation and pressure. *Injection* of the

* See also "Formation of Synovial Cysts in connection with Disease of the Knee-Joint," by B. W. Morrant-Baker. (St. Bartholomew's Hosp. Reports, vol. xiii.)

joint with tincture of iodine has been much employed by Velpeau, Jobert, and Bonnet. The tincture is diluted with two or three parts of water. A small trocar is introduced into the joint, a portion of the serous fluid let out, and a corresponding quantity of the iodine solution thrown in, and after being left for a few minutes, according to the degree of pain excited, it is allowed to escape, and the puncture carefully closed with a pad of lint, secured by strips of adhesive plaster. The joint may be bandaged, but compression should be removed, if pain be induced. After the operation, the joint fills again with serous effusion, so as to be even larger and more fluctuating than before, and somewhat painful; but in about a week, absorption proceeds slowly to recovery. On the other hand, very disastrous consequences have ensued: purulent synovitis, with destruction of the joint, and pyæmia; or anchyolosis, as a less unfavourable result. Considering the danger to limb and life consequent on injection, and the more harmless although persistent nature of hydrops articuli, the Surgeon may well pause before having recourse to this procedure. The precautions necessary are—a very chronic, passive state of effusion; and that no air should enter the joint, either from the syringe, or in withdrawing the canula and closing the puncture. Constitutional treatment, by the influence of iodide of potassium and cinchona bark, cascarilla, or other tonics, will aid these local measures. In hydrops articuli, the fluid has, I believe, been removed by the aspirator, whether without return may be doubtful.

Suppuration and abscess, in the interior of a joint, should be met promptly, by evacuation of the matter. The presence of pus having been first assuredly ascertained by puncturing the joint with a grooved needle, an opening with a bistoury should be made forthwith, freely, and in a dependent situation. This proceeding was, I believe, originally advocated by Mr. Gay, and it has been sanctioned by subsequent experience. Perfect rest of the joint must then be secured by splints, and the limb placed in the position most convenient for use, in the event of anchylosis. A suitable kind of anchylosis having been attained, fibrous or osseous, according to the use of the limb, it will be unnecessary to have recourse to further operative interference, by excision or amputation. Constitutional treatment consists in the tonic and medicinal resources and supporting regimen requisite to sustain the exhaustion of hectic.

Chronic Rheumatic Synovitis, or Chronic Rheumatic Arthritis.—*Structural Condition.*—This inflammatory disease involves other joint-textures besides the synovial membrane; but that is the texture first affected. Sir B. Brodie, Cruveilhier, and Dr. R. Adams alike concur in this view of the structural origin of the above-named disease. Hence, the term synovitis seems preferable to that of arthritis, proposed by Dr. Adams; the etymological signification of the latter term including inflammation of any or all the structures of a joint (ἄρθρον, a joint). Billroth refers the origin of the disease, generally, to the articular cartilages, which undergo a fibrous or filamentous degeneration; and Mr. Barwell locates the initial change in the bone, as a rheumatic ostitis.

Chronic Rheumatic Synovitis differs only from ordinary Chronic Synovitis in certain particulars as to its pathology and treatment, which are, however, worthy of separate notice. The inflammation of the *synovial membrane* seems to affect the vascular fringe-like pro-

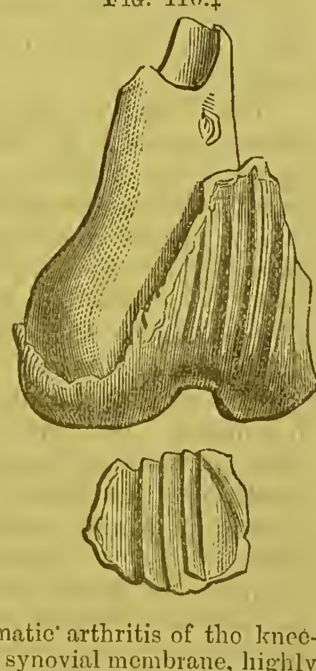
cesses of this membrane more particularly, which are much developed and injected; the internal surface of the capsule presenting the appearance of a villous mucous membrane. (Fig. 408.) Effusion

FIG. 408.*

FIG. 409.†

of fluid within the joint takes place to a moderate amount, and is eventually absorbed. But the membrane itself remains thickened and fibrous; while osteophytes or osseous deposits frequently form partly in its substance, principally around the joint, connected with the periosteum and articular ends of the bones. (Fig. 409.) These ossific formations are nodular, and have a denser or more compact structure; unlike the long and spiculated, stalactitic osteophytes, and of a porous or more cancellated structure, which result from either periosteal or osteal inflammation. Hence the term *nodosity* of the joints, proposéd by Dr. Haygarth, as expressing one of the most distinctive features of chronic rheumatic synovitis or arthritis. The *ligaments* become relaxed; the *articular cartilages* undergo peculiar changes; becoming fibrous and having a yellowish hue, nodular, and then rough, ultimately being destroyed, and presenting patches of ivory-like bony material or porcellanous deposit, white, smooth, and glistening. This acquires even a high polish under the attrition of the surfaces, and linear furrows are formed in the directions of friction by the movements of the joint.

FIG. 410.‡



* St. Thomas's Hosp. Mus., D. 100[1]. Chronic rheumatic arthritis of the knee-joint—*early* stage; showing hypertrophied fringes of the synovial membrane, highly vascular; with denudation of the articular cartilage over the inner condyle of the femur and corresponding surface of the tibia, and a slight circumferential collar of ossific deposit. Disease, one year's duration.

† Chronic rheumatic arthritis—femur in knee-joint. Mr. Canton's case ("Trans. Path. Soc.," vol. xii.).

‡ St. Bartholomew's Hosp. Mus., B. 62.

(Fig. 410.) Inter-articular ligaments and fibro-cartilages are more or less destroyed and disappear; thus, the round ligament in the hip-joint, and the long head of the biceps in the shoulder-joint, are removed by absorption. The sub-cartilaginous *osseous* structure is much condensed, and the whole articular end of the bone enlarged and deformed by the surrounding osseous growths; while the *articular surfaces* become singularly altered in *shape*. Thus, the globular heads of the femur and humerus are flattened and expanded, and their necks shortened; the corresponding articular cavities also being enlarged and shallow. These alterations, with the bony buttresses thrown out around the articular ends, have sometimes been mistaken for fracture with bony union, in examining such pathological specimens of the neck of the femur or humerus. *Multiple* exostosis of the knee-joint resembles chronic rheumatic arthritis, in the advanced stage of this disease; but the exostoses are capped with cartilage (Fig. 411), and thus differ from the purely ossific deposits consequent on rheumatic arthritis.

Fig. 411.*

The *Signs* of chronic rheumatic synovitis or arthritis are distinctive:—pain, enlargement and ultimate deformity of the joint, rigidity or stiffness, and a peculiar crackling or grating noise on moving the joint. The pain is not acute, but of an aching, boring, or gnawing character, worse at night, increased by motion, but passing off somewhat by exercise during the day, and aggravated by cold and moisture; it is, in short, rheumatic pain. The general health may remain comparatively unaffected for years.

The *Causes* of this disease always have reference to the constitutional condition of Rheumatism, and sometimes exposure to cold or injury as an exciting cause. Thus, chronic rheumatic synovitis may result from rheumatic fever or from repeated attacks of rheumatism; or in a person predisposed, direct exposure of a joint to cold or some slight injury, as a sprain, may evoke the disease. Many joints are liable to be affected, the disease passing from joint to joint without relieving those originally attacked; or only one joint may be affected. The larger joints, especially the hip and knee, seem to be most frequently attacked in males; the smaller joints, as those of the fingers, in females. But, apart from this relative difference, both sexes would seem to be nearly equally liable to the disease. Age has no special proclivity; the disease usually occurs after mid-life, but it may also appear in young persons. Thin, bloodless, chilly persons are more often subject to chronic rheumatic arthritis. No social condition is exempt; the poorly fed and hard-worked being prone, the luxurious and indolent subject, to this disease; in the latter class, assuming the character of *rheumatic gout*.

Course and Terminations.—Chronic rheumatic synovitis is singularly persistent, evincing little tendency to subsidence, or termination by resolution. The irregular enlargement and deformity of the joints, with the weakened state of the ligamentous structures, and altered

* St. Thomas's Hosp. Mus., C. 237[1].

shape of the articular surfaces, predispose to *partial dislocations* and *contractions* of the limbs; leaving the patient stiffened and crippled in his movements, and ultimately reduce him to a helpless condition. Loose cartilages, moreover, are apt to form in the joints. Suppuration rarely, if ever, occurs; the disease—apart from any temporary effusion of fluid—is essentially a *dry* disease of the joints. Anchylosis also is a rare event; although the increasing articular rigidity, and wasting of the disused muscles, have an equivalent result. At last, the general health declines, and the patient becomes emaciated to a shadow.

Treatment.—Preventive measures, in the early stage of this disease, may succeed in averting its destructive consequences; but any curative measures for the removal of the osseous deposits or out-growths, and restoration of the disorganized state of the joints—in respect to ligaments, synovial membrane and cartilages—will have scarcely any avail. *Local* treatment—in the early stage—is that of synovitis. Rest of the joint, and slight topical depletion by a few leeches, may now prove efficacious. But, as the symptoms of inflammation subside, leaving some structural results—in thickening of the synovial membrane and effusion within the joint—counter-irritation, by means of blisters or iodine paint, will become advantageous. Stimulant embrocations and friction, as by shampooing or local douches, and motion, may then succeed in recovering the use of the joints. The *constitutional* treatment should be that of rheumatism. In the early stage, bicarbonate of potash, in large doses, with wine of colchicum, may arrest the progress of the disease. Subsequently, iodide of potassium and guaiacum seem to have more controlling influence. Free action of the skin must be promoted by warm clothing and sudorific medicines, as Dover's powder and hot-air baths; while a rigorous attention to diet will be indispensable when the disease has a *gouty* character, with dyspeptic symptoms, denoting a constitutional origin of that kind. Nor should hydropathic treatment be disdained, when properly conducted. Mineral waters, coupled with a due observance of dietetic precautions, sometimes prove singularly beneficial in rendering joints supple and restoring the general health, at least for a time. The waters of Bath or Buxton in this country, Vichy, Wiesbaden, Carlsbad, Ems or Aix-la-Chapelle on the Continent, are thus hopeful resorts for the victims of chronic rheumatic synovitis; and such patients should, if possible, winter abroad, out of the cold, damp, and variable atmosphere of this country, in the genial climate of Nice and other parts of Italy, or the south of France.

Scrofulous Synovitis.—*Structural Condition.*—A pulpy or gelatinous degeneration of the synovial membrane, resulting from inflammation of a *chronic* character, modified by a scrofulous constitutional condition.

The synovial membrane, in this state, is thickened and converted into a soft yellowish or light-brown gelatinous material; more vascular also than the healthy membrane. This change may be partial in its extent, affecting only the membrane reflected over the ligaments, or over the cartilages. Sir B. Brodie, who first described this disease, relates such cases as shown by dissection. The articular cavity becomes diminished as the pulpy thickening of the membrane encroaches on the joint; and this taking place most freely in the loose synovial

folds which surround the cartilages, they are often concealed by the new formation. (Fig. 412.) Billroth's special observations show that the circumferential synovial folds proliferate, in the shape of red spongy granulations, overspreading the cartilage, and to which this fleshy layer becomes firmly adherent, by roots or processes entering the substance of the cartilage. A similar pulpy material forms in the areolar texture around the *outer* surface of the membrane, which thus becomes infiltrated and condensed. This gelatinous material apparently results from a failure in the process of development of the products of inflammation; in acute and healthy synovitis, a fibrous or areolar tissue being produced; whereas in scrofulous inflammation, development does not advance beyond the first form of crude cell-structure. Many intermediate gradations, however, may be found between these two conditions.

FIG. 412.*

The knee-joint is most commonly affected; less often, the hip.

Signs, and Diagnosis.—In an early stage, a sense of stiffness of the joint is experienced and tumefaction appears, on either side of the patella; beginning almost imperceptibly, but slowly and gradually increasing; with absence of pain, even on moving the joint. The child walks with a limping or dragging lameness. These early symptoms are not very characteristic. In a more advanced stage, after the lapse of a few months, a very considerable enlargement is presented, generally of an irregular shape, colourless and elastic, without any distinct fluctuation. The joint has now become tender on pressure, painful when moved, and the limb more or less bent. This disease most resembles scrofulous caries of the articular ends of the bone in the joint affected. But the *swelling* is diagnostic, in its being more obviously referable to the synovial membrane than to the end of either bone. From cancerous disease of either articular end of bone, the same feature of distinction may be available for diagnosis; while the whiteness of the skin contrasts with the reddish or purplish discolouration which sooner or later supervenes in malignant disease, as the skin becomes involved. The lymphatic glands also are not contaminated.

Course and Terminations.—As the disease progresses, the cartilages undergo *ulceration* in spots, where the spongy processes are imbedded; though these spots are not, necessarily, at first, in direct relation with the pulpy synovial membrane. The changes which ensue are fully described in tracing the Ulceration of Articular Cartilages. Abscess forms within the joint, or in the substance of the swollen membrane; and making its way to the surface, opens by various sinuous apertures. Hectic supervenes.

Occasionally, the disease subsides. The gelatinous growth is directed inwards towards the articular cavity, which it tends to fill up; while the material itself becoming more fibrous, and contracting,

* Royal Free Hospital. Scrofulous synovitis of knee-joint. Amputation. (Author.)

still further diminishes the cavity. *Anchylosis* of the osseous surfaces completes this process of recovery, but leaving the limb much wasted, the muscles having undergone fatty degeneration, so that the joint appears conspicuously enlarged. Rarely, the synovial membrane itself is restored to a healthy state; *absorption* taking place, and the articulation remaining structurally sound. Two or three years may have been spent in any such course of natural cure.

Treatment.—Remedial measures must have regard to the constitutional condition, and hence the treatment of Scrofula is here appropriate. Local treatment consists in absolute rest of the joint, and the observance of a suitable position in the event of anchylosis. Hence, the use of a properly adapted splint may be, or become, necessary. Counter-irritation should be applied cautiously, by means of iodine paint, or occasional blistering. The actual cautery is, however, strongly urged by Mr. Barwell, when enlargement of the joint is proceeding without any notable inflammation. The iron should be white hot, and applied in lines, about an eighth of an inch broad and three inches long, parallel to the axis of the limb. Four such lines are recommended for the knee, two on each side of the patella, at least an inch apart; dry lint being then applied. This proceeding resembles the "firing" of a joint, as practised in veterinary surgery. The advantage of counter-irritation, by means of the actual cautery and as thus applied, is said to be not only its derivative effect, but the pressure which ensues from the contracting cicatrices. When the swelling is reduced to a passive state, Scott's dressing may be used as a means of counter-irritation, and the plaster affords more support. Friction and gradual motion will then finish off the disease, and restore the use of the joint.

Ulceration of the articular cartilages, with abscess and destruction of the joint, may be followed by anchylosis, and a useful limb, under continued treatment by rest and position; but the destructive result of scrofulous synovitis will more probably necessitate the removal of the diseased part, either by excision or amputation. The latter operation may be sometimes imperative, owing to the constitutional exhaustion rather than the extent of the disease. Loss of limb will then be alternative to the loss of life; the patient, otherwise, inevitably sinking under prolonged hectic.

Scrofulous Disease of the Joints, or scrofulous inflammation and *caries* of the cancellated structure of the articular ends of Bone.—A disease of *chronic* character.—*Structural Condition.*—The alterations of the cancellous structure in this state of disease are fully described in Diseases of Bone. The changes alluded to may be summed up as inflammation and consequent caries; differing only from ordinary inflammation of bone in the nature of the products associated with the disintegrative transformation. At first, the cancellous structure is simply more vascular than natural, then it becomes softened and porous; while the cancelli are filled with a reddish gelatinous fluid, and ultimately an opaque, friable, tuberculous matter. (Fig. 413.) Caries appears frequently in separate points of the cancellous tissue, which, gradually extending, coalesce. At variance with this received view respecting the pathology of scrofulous caries affecting the articular ends of bone, Dr. Sayre, of New York, refers this disease to an extravasation of blood in the cancellous tissue immediately beneath the arti-

cular cartilage,* and which, inducing inflammatory softening, results in caries, followed by ulceration of the cartilages, and destruction of the joint. Hence, Dr. Sayre denies also the constitutional origin of the so-called *scrofulous* disease of a joint, or "white swelling," although this local condition of disease may sometimes occur in persons of an undoubtedly scrofulous diathesis, but simply as an "accidental accompaniment;" the disease arising from an intra-osseous extravasation of blood, in connection with injury to the joint, and thus being of *traumatic* origin. I do not find this new pathology verified by any *specimens* of extravasations of blood in the articular ends of bone, coupled with clinical histories as of initial scrofulous disease of the joints thus affected.

FIG. 413.†

This disease is commonly situated in the articular ends of the long bones; particularly the head of the femur, in scrofulous disease of the hip-joint; in the head of the tibia or lower articular end of the femur, in similar disease of the knee-joint; in the bones of the tarsus; in those of the carpus; in connection with the elbow or shoulder joints, occasionally; and not unfrequently in the cancellous tissue of the bodies of the dorsal or lumber vertebræ. Nor do these situations exhaust the list of bones liable to be affected by scrofulous caries.

Signs.—Scrofulous caries of the *knee-joint* may be taken as typical of the *general* symptoms. The disease approaches very insidiously, being preceded by little or no pain. Some inability to use the joint—a limping lameness in walking—first attracts notice. A child, for example—the disease occurring commonly before puberty—drags his foot after him in walking. Weeks or perhaps months elapse ere pain is complained of; and then only a trifling pain, intermittent, but fixed, and aggravated by any movement of the joint, or especially on percussion of the bone below, as of the foot in disease of the knee-joint. This pain increases as the disease progresses. At length a swelling of peculiar character forms around the joint, arising from infiltration of the cellular texture with serum and lymph. A puffy, elastic swelling is thus produced, which assumes a *globular* shape, while the skin retains its white colour, constituting the "white swelling" (Fig. 414) formerly recognized in Surgical works. This swelling becomes more conspicuous and apparently larger than it really is, owing to gradual wasting of the muscles above and below the diseased joint. Scrofulous

FIG. 414.‡

* Orthopedic Surgery and Diseases of the Joints, 1876.
† St. Bartholomew's Hosp. Mus., 1, 38.
‡ Royal Free Hospital. (Author.)

enlargement of the knee-joint, for example, thus *differs* notably in its characters from the swelling of Synovitis. The absence of pain in the first instance, and for a considerable period, is also diagnostic. In either disease, the limb becomes somewhat flexed, from muscular action prevailing in that direction. The general health remains comparatively undisturbed up to this period.

Necrosis in the articular end of a bone might be mistaken for scrofulous caries, as in disease of the knee-joint. But the absence of the peculiar globular swelling will be noticed, while the thigh becomes progressively enlarged (Fig. 415); and in a later stage, when abscess has formed and burst, a fistulous opening is seen *above* the joint, and by introducing a probe the sequestrum may be detected.

Fig. 415.*

Fig. 416.†

Course and Terminations.—Scrofulous caries of a joint may *subside*, leaving only some œdematous swelling and stiffness of the joint. Or, the disease progresses, both to the surface and the interior of the joint.

In the one direction, as the disease advances, the periosteum becomes detached, *suppuration* takes place *around* the joint, and sinus-openings form, leading down to worm-eaten carious bone, and giving vent to a foul discharge. The textures are undermined and traversed by sinuses in various tortuous ways, according to the anatomical relations of the joint. (Fig. 416.) Towards the *joint*, as caries extends, the nutrition of the cartilages, depending on the osteal vessels, becomes impaired. Their attachment to the bone is loosened, and they acquire a fibrous character. *Ulceration* commences usually on the deep or osseous surface of the cartilages; as a disintegration equivalent to the carious state of the bone. Portions of cartilage may be detached and lie loose within the joint. Sometimes the ulceration assumes a peculiar form, which has been named "spotted ulceration;" there being several pits containing a curdy matter in the articular surfaces, and which correspond to pits in the bone, while the intervening portions of cartilage remain unaltered.

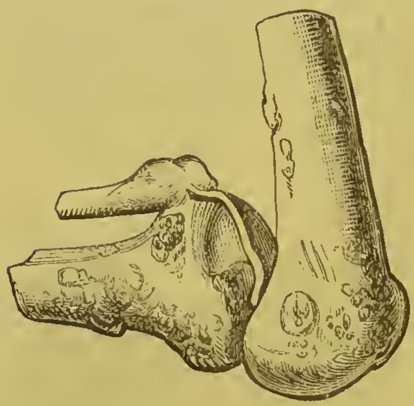
Ulceration of the articular cartilage is announced by painful startings of the limb, occurring particularly at night. Synovitis speedily supervenes, and the formation of matter *within* the joint. The opposite

* Royal Free Hospital. Amputation of the opposite thigh for necrosis; there was also angular curvature of the spine. (Author.)

† After Liston.

articular cartilage becomes affected and the bone exposed. The two sensitive osseous surfaces meeting together and being subject to attrition and pressure by spasmodic action of the muscles, the starting pains are much aggravated. The ligaments share this destructive progress of the disease, and give way; the *abscess* within the joint bursts through the synovial membrane, and at length finds its way to the surface, with sinuous openings around the joint. The head of the bone, altered in size and shape, and no longer restrained by ligamentous connections, undergoes *dislocation*, in whatever direction the disease may facilitate displacement, and subject to the action of the muscles. In the remarkable case here figured, from disease of the knee-joint, the tibia is dislocated backwards, and to a right angle with the femur. (Fig. 417.)

Fig. 417.*



The joint has now become irreparably disorganized; but *anchylosis* may take place without dislocation, or an imperfect *joint* form after dislocation, the bone remaining in its new locality. Either of these reparative terminations, in the course of nature, are rare.

Constitutional disturbance of the most severe kind accompanies the destructive course of this disease; and the patient probably sinks ultimately from long-continued pain and sleeplessness, purulent discharge, and the night sweats of hectic.

The concurrence of scrofulous disease in other organs than the joints must not be overlooked in our *prognosis*. Thus, the lungs or mesenteric glands may be affected with tubercular deposit; or tubercular meningitis ensue, with effusion into the ventricles of the brain. And the social state of the individual should be taken into account; scrofulous disease arising and progressing far more readily in the poor and needy, than in the affluent classes of society.

Treatment.—Local appliances are of subordinate importance to constitutional treatment, yet they are co-operative in arresting scrofulous caries and the reparation of its destructive consequences.

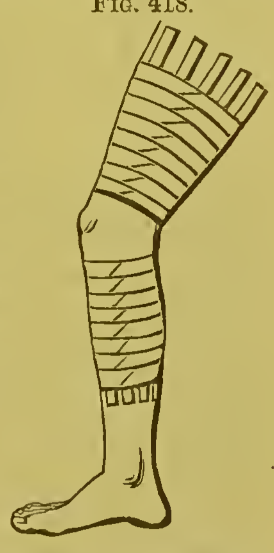
In the first place, absolute *rest* of the limb is an essential condition throughout this disease; in the earliest stage to arrest its progress, subsequently to relieve pain and induce anchylosis. Due regard should also be had to the *position* most favourable for the future use of the limb, in the event of this issue. Such rest, and position, can only be secured by means of a suitable splint. A leather or gutta-percha splint moulded to the joint answers best, generally. But the splint must be of sufficient length to fix the limb entirely, and check any contraction of the muscles which would affect the joint. Thus, in scrofulous disease of the hip-joint, a gutta-percha splint should be applied so as to embrace one side of the pelvis and two-thirds of the circumference of the thigh, and extend from the short ribs to below the knee. The limb should be in a line with the trunk, or bent only *slightly* forwards. For the knee-joint, two lateral splints are preferable; supporting two-thirds of its circumference, and extending from the middle of the thigh to the middle

* Guy's Hospital Mus., 1345.

of the leg. A *slightly* flexed position will be the most convenient in the event of anchylosis. For the ankle, also, two lateral splints may be made to include the lower part of the leg and the sole of the foot; the patient being allowed to walk about with the knee supported by a wooden leg. Disease of the bones of the foot will require the support of a splint moulded to the sole, and turned round the inner and outer side. Over this, a large cloth boot may be worn, whereby the patient can walk about without injury to the diseased joints. In the upper extremity, scrofulous disease of the joints must be treated on a similar principle as to rest and position. For the shoulder, a splint should be moulded to the joint, and extend down the arm to the elbow; the forearm being suspended in a sling from the neck. A diseased elbow-joint is best supported by lateral splints; the wrist by a splint on its palmar surface, extending upwards to near the elbow and downwards to the tips of the fingers, and doubled at its margins over the sides of the hand and forearm.

In an *advanced* stage of the disease, when painful startings of the limb and a tendency to dislocation have supervened, it becomes advisable to slightly separate the diseased *articular* surfaces, and counteract muscular contraction. Some *extending* force, moderate but constant in its operation, may be advantageously resorted to; the application and beneficial results of this plan of treatment having been more especially advocated and illustrated by Dr. Sayre.* For the hip-joint, Liston's long splint, interrupted, will accomplish this purpose. But I prefer weight-extension from the foot, as in the treatment of fracture of the thigh. The knee-joint is, perhaps, best managed by a pulley sling-apparatus which encloses the limb in a canvas trough; while slight extension is maintained by the inclined direction of the pulleys. This apparatus—applicable also to fracture of the thigh or leg—gives great ease and comfort in advanced disease of the knee-joint. When any tendency to dislocation has been overcome, Dr. Sayre's extending-instrument may be used with advantage. For its application he gives the following directions:—"Surround the leg with strips of adhesive plaster about one inch in width, placed lengthwise, and reaching from the head of the tibia down to the ankle-joint, and secure them with a roller-bandage from the top down to the point at which the lower band of the instrument is to be applied, leaving four or five inches of the lower ends of the plaster loose, fastening the bandage with stitches. Then, surround the thigh with strips of adhesive plaster of about the same width, applied in the same manner, and extending lengthwise upon the thigh from the lower end of the femur, nearly its whole length. Secure these plasters with a nicely adjusted roller-bandage, from the knee upward to the point where the upper band of the instrument is to be applied, leaving the remaining portion of the plaster loose. (Fig. 418.) Place the instrument on the limb so as to bring the side-bars upon the same plane with the condyles of the femur, an assistant holding it steadily in that position. The collar embracing

FIG. 418.



* Op. cit.

the leg should be closed so as to closely engage the leg, but not to prevent a free return of blood. Now reverse the loose extremities of the strips of adhesive plaster, bring them over the collar and upon the leg, and secure by a few turns of the bandage. Press the lower collar down into the plasters which engage it, and then secure the upper band about the thigh. This can be done by taking one piece of plaster behind and another in front, at points exactly opposite upon the circumference of the limb, and reversing them in such manner as to bring equal traction upon the collar posteriorly and anteriorly, which will balance it so that its edges will not come in contact with the thigh at any point,—thus to avoid pressure. The remaining strips of plaster can be reversed without causing the edges of the roller to make pressure at any point, and all are then secured with a roller-bandage. Thus, the instrument is fastened at its upper and lower ends, ready for extension and counter-extension. This is effected by means of the key and rachet on the bars of the instrument. (Fig. 419.) The amount of extension should be determined and regulated by the perfect relief from all pain in the joint, and on pressure or concussion; avoiding unnecessary tension on the lateral ligaments. This degree of extension having been obtained, the instrument is locked by the slide and retained there." The ankle-joint may be treated in like manner, by Sayre's extending-instrument, similarly applied by means of longitudinal slips of adhesive plaster, secured in position by a roller-bandage; and then the application of the instrument. (Fig. 420.)

Fig. 419.

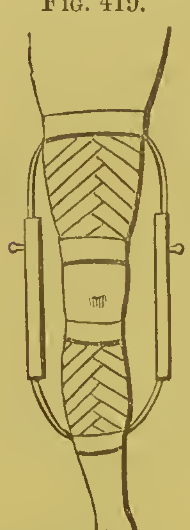
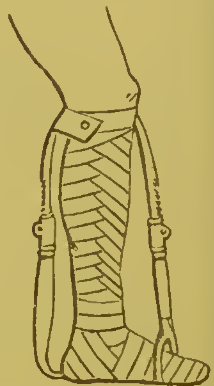


Fig. 420.



Lastly, whatever be the *termination* of scrofulous caries, a *starched bandage* is an exceedingly useful support. If the disease be arrested, leaving only some œdematous swelling of the joint, the uniform pressure of this support will aid in reducing the swelling, and the patient can get about on crutches—supposing the lower limb to be affected—with the benefit of air and exercise. If anchylosis have ensued, or a new joint as the result of dislocation, the support of a starched bandage will be equally advantageous. The period of time necessary for the use of some support to the seat of disease is always considerable; many months, possibly years.

Other local treatment—from first to last—may be regarded as comparatively unimportant. Scrofulous disease of a joint cannot be arrested by any depletory measures, and in proportion as they reduce the general health such measures are positively injurious. *Local blood-letting*, by a few leeches, may sometimes prove beneficial in the incipient or vascular stage of the disease. But the repeated loss of blood would be injurious. *Counter-irritation*, by blisters, setons, etc., has an equally restricted applicability. The discharge and pain they occasion more than counterbalance any good resulting from their *derivative* action, especially in children. If the disease subsides, with œdematous swelling,

stimulating applications have some beneficial influence. Hence, embrocations, iodine paint, and douches of sea-water, are now useful. Pressure also—as by a starched bandage, or pressure with stimulation—by Scott's strapping, may be applied with advantage.

Abscess having formed around the joint—in the course of the disease—a free and dependent opening should be made in time to prevent burrowing of the matter. The starched bandage can still be used, with a trap-opening opposite the abscess, for the convenience of dressing and cleanliness. When also ulceration of the articular cartilages has taken place, and the formation of abscess within the joint, anchylosis may be obtained, by continued rest, and position suitable to a useful limb. Failing this result, timely excision must be had recourse to, before the supervention of hectic and exhaustion, when amputation becomes the only resource. Prof. Billroth and many other German Surgeons look with something like dismay on the consequences of joint-excision, for disease in general; and the clinical picture drawn from *their* experience of the operation would amply justify the sacrifice of the limb by amputation. After re-section, we have left a large wound, with two sawn edges of bone, "which will certainly continue to suppurate for weeks, possibly for months; there may be suppuration of the subcutaneous tissue, of the sheaths of the tendons, and suppurative periostitis and necrosis of the sawn edges, things which patients may live through, but which always require time and strength." *

The local treatment of scrofulous caries of a joint thus generally resembles that of scrofulous synovitis, in respect to rest and position of the joint, topical applications, and the treatment of abscess. The *constitutional* treatment of this disease is precisely that of Scrofula. This treatment consists in a course of tonics, especially the preparations of iron and quinine, a nutritious diet, including cod-liver oil, pure air, daily exercise, and sea-bathing. The administration of medicinal tonics should be varied from time to time, and with occasional intermissions. For children, the vinum ferri seems preferable, and after a while the syrup of the iodide of iron may be given in exchange; these and other simple preparations of iron being continued for three or four weeks, and then omitted for a week or ten days. But this course of treatment must be extended over a considerable period, probably two or three years.

Ulceration of Articular Cartilages.—*Structural Condition.*—The articular cartilages, when fully developed, and in a healthy state, are destitute of blood-vessels (and nerves). Nutrition is effected—as in the cornea—by imbibition; the nutrient matter being drawn from the blood-vessels of the subjacent bone and vascular fringe of the synovial membrane around the circumference of the cartilage. As the result of inflammation—according to the observations of Sir B. Brodie, Mayo, and Liston—blood-vessels extend into the cartilages from the subjacent bone; just as they form in extravasated lymph. Hence the nutrition of articular cartilages, in this state, depends on a supply of nutritive matter, directly from the vessels, as in other vascular textures. But this question of the *vascularity* or *non-vascularity* of cartilage, with regard to the more or less direct supply of blood, has nothing whatever to do with the nutri-

* "Surgical Pathology and Therapeutics," p. 471. 4th edit., German. Translated by C. E. Hackley.

tive process itself as pertaining to the elemental structures, in health and disease. In respect to ulceration of the articular cartilages, the researches of Goodsir and Redfern, more particularly, have shown that it represents a vital alteration in the cartilaginous structure itself; and that the influence of the neighbouring blood-vessels is only indirect or secondary.

As consequent on inflammation of the *synovial membrane*—synovitis, or of the *bone*—ostitis, ulceration of articular cartilage may be named *inflammatory* ulceration, or *secondary*, in its relation to the original disease. Similar ulceration may perhaps occur as an original disease of the cartilage, and is hence named *primary* ulceration. But this state would seem to be, usually, a degenerative disintegration. Degeneration also precedes inflammatory ulceration when the disease originates in *bone*, and extends to the cartilage as a secondary affection.

Fig. 421.*

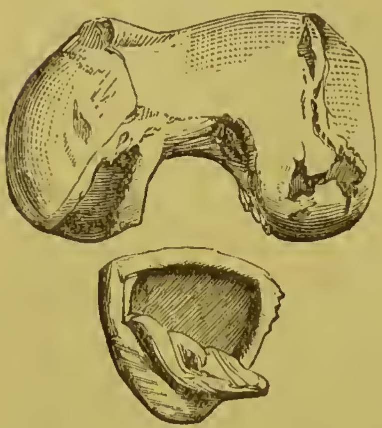


Fig. 422.†

Ulceration may *begin*, either on the *free surface* of articular cartilage, or on its *attached* surface; and at its *margin*, where the synovial membrane is reflected over it (Fig. 421), or in the *substance* of the cartilage. In the hip, it may commence close to the attachment of the round ligament; or in the knee, adjoining the crucial ligaments.

Forming shallow excavations, these assume the appearance of grooves, at a greater or less distance from the margin and frequently in the central parts of the cartilage. Nearly the whole cartilage may disappear, leaving only a few isolated reddened patches. In contrast with ulceration, gouty deposit appears in the form of white patches, but raised above the level of the cartilage (Fig. 422), which might otherwise be mistaken for ulceration.

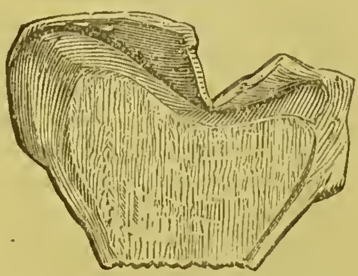
Inflammatory ulceration, consequent on *synovitis*, presents the following alterations on the free surface of the cartilage. The colour of the cartilage is altered in spots; which either rapidly become holes, as if cut out with a chisel, or the spots assume a fibrous aspect, and becoming excavated, form pits with fringed margins. In this way, the cartilage may be extensively destroyed, and the bone laid bare. Or, and especially in scrofulous synovitis, a thick vascular membrane forms, which passes from the diseased synovial membrane over the cartilage. The cartilage is slowly transformed into a kind of granulation, between which and a similar material growing from the synovial membrane, adhesions ensue, resulting in absolute continuity. When ulceration of the cartilage has extended deeply, the bone becomes

* St. Bartholomew's Hosp. Mus., 2, 32. † Ibid, 2. 33.

involved, and the cancellous tissue acquires undue vascularity. The articular lamella of bone—a layer of calcified cartilage—crumbles or breaks up in masses, carrying with it portions of cartilage; and the granulations springing from the exposed cancellous tissue unite with those of the synovial membrane.

Ulceration consequent on disease of the *subjacent bone* consists in degeneration, followed usually by inflammatory ulceration. A portion of the cartilage, losing its nutrient supply, degenerates or perishes, and is detached with its articular lamella from the inflamed surface of bone—as from the articular surface of the head of the tibia, a section of which is here shown (Fig. 423)—whilst the surrounding portions of cartilage undergo the changes described as taking place in ulceration from synovitis.

Fig. 423.*



The *minute* changes in the process of ulceration relate both to the cartilage-corpuscles and the inter-cellular or hyaline substance. The corpuscles enlarge, with an endogenous development of cell-structures, and bursting, discharge their contents into cavities in the tissue itself, or upon the free surface, mingling with the organic matters contained within the joint, and probably forming pus. (Fig. 424.) This endogenous productiveness is greater, the nearer to the seat or focus of disease. There, instead of two or three nucleated cells, the corpuscles may contain an almost indefinite number of younger cells, resembling

Fig. 424.†

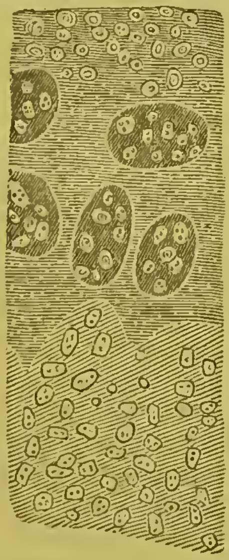


Fig. 425.†

pus-globules. The inter-cellular or hyaline substance disintegrates, or, in more chronic ulceration, it splits into bands or fibres of varying size, in the midst of which, sometimes, are found gelatinous masses —the changed contents of the cartilage-corpuscles, as Dr. Redfern supposes. (Fig. 425.)

These changes proceed more or less rapidly in proportion to the

* St. Bartholomew's Hosp. Mus., 2, 6.

† After Redfern.

activity of the disease; thus representing the *acute* and *chronic* varieties of ulceration. In one case, the patient having died after venesection, Mr. Lawrence believed that complete destruction of the articular cartilages of the femur and tibia took place in four days. Chronic ulceration may progress very slowly, especially when of rheumatic origin.

Signs and Diagnosis.—(1.) *Secondary* ulceration of the articular cartilages is announced by the *starting pains* adverted to in connection with the *progress* of synovitis and scrofulous caries; and the articular disease is preceded by the symptoms of one or other of these diseases. (2.) *Primary* ulceration, of an inflammatory character, is said to present certain special and distinctive signs, as compared with synovitis or caries. According to the original observations of Sir B. Brodie, *pain*, fixed and intense, is the earliest symptom, and coincident with the *commencement* of the disease. This pain is aggravated by movement of the joint, or friction, rather than by percussion of the bones, and accompanied with startings of the limb, as muscular spasms supervene. In the course of weeks or months, slight *swelling* arises, corresponding in shape to the margin of the affected cartilages, and produced by serous effusion into the cellular texture externally. Abscess, within the joint, follows. But my own experience has led me to doubt whether inflammatory ulceration of articular cartilages ever occurs as a primary affection.

Repair—after ulceration of articular cartilage—takes place in different ways. Extensive destruction of the opposed cartilages, with exposure of the cancellous bone, may be followed by the formation of granulation-tissue, uniting the osseous surfaces, and resulting in anchylosis. Ulceration affecting the cartilage to a considerable depth is sometimes repaired—as Redfern describes—by the formation of a fibro-nucleated membrane from the substance of the cartilage, without the occurrence of any new exudation. Occasionally, a patch of ivory-deposit or porcellanous-encrustation occupies the place of a portion of cartilage; or a scar alone marks the seat of a former ulcer.

Treatment.—The *local* treatment is the same as for other inflammatory diseases of the joints. Absolute rest, and position of the joint, must be observed, and for a considerable period. Counter-irritation, by blisters, issues, or caustic potash, may be applied more advantageously than in scrofulous caries. Abscess must be opened forthwith, and anchylosis induced, as the only favourable termination in this advanced state of the disease. Excision or amputation are ulterior resources, which will be considered with reference to Diseases of the Joints specially. (Chapter I. Vol. II.) The *constitutional* treatment resembles that for rheumatism affecting the joints. Mercury, in the form of calomel, the bichloride, or blue pill, combined with opium, should be administered, and pushed to slight salivation. Mercurial inunction must be resorted to, if the internal administration disagree. This may be followed by iodide of potassium and sarsaparilla. But a gradual subsidence of the joint-symptoms will declare whether the articulation itself is preserved, or anchylosis be inevitable.

Anchylosis, or Stiff Joint.—*Structural Conditions.*—Two states of anchylosis are recognized: the *fibrous* or incomplete, and the *osseous* or complete. Both signify the junction or union of the *articular* surfaces of the *bones*, thus presupposing the partial or complete removal of the articular cartilages; unless occasionally, in fibrous anchylosis, where

bands of false membrane may be thrown across the synovial capsule, forming adhesions, or the natural folds of the synovial membrane may have become adherent, with some stiffness of the joint. Either condition of anchylosis may be *extra-capsular;* the fibrous consisting of a thickened and indurated state, or perhaps cicatricial contraction, of the ligamentous capsule, with adhesions around the joint; and osseous anchylosis externally, being the formation of new bone around, and on the articular surfaces of, the joint. Besides these conditions, a species of anchylosis or stiff joint may depend on partial dislocation, from destructive disease of the joint, or an unreduced partial displacement by injury. A contracted state of the muscles, or of a cicatrix, acting on a joint, may also produce stiffness of the articulation,—not, properly speaking, an anchylosis.

(1.) *Fibrous* anchylosis is liable to happen to any joint; and the shortened and contracted state of the muscles acting on the joint gives an apparent firmness to the anchylosis, beyond that due to the joint-condition; a portion of the articulation generally remaining sound.

FIG. 426.*

(2.) *Osseous* anchylosis occurs most commonly in the hip, knee, or elbow (Fig. 426); the articular surfaces seeming to be fused together, as seen more clearly on a vertical section of the bones.

Both states of anchylosis are attended with a proportionate loss of mobility in the joint; the fibrous allows of some degree of motion, more so, perhaps, under chloroform; the osseous presents a perfectly rigid and immovable joint. But firm adhesions, short and extensive, may simulate osseous anchylosis; and the probability of the latter having taken place will then depend on the long duration of an immovable condition.

Both anchyloses are accompanied with more or less *deformity* of the *limb*, arising from mal-position of the bones obediently to muscular contraction; unless the anchylosis has resulted under proper and effectual surgical supervision.

The *Causes* of anchylosis have reference to inflammatory diseases of the joints; synovitis, or caries; and, perhaps, primary ulceration of the articular cartilages, as already described. Destruction of the cartilages, in either case, may be succeeded by *reparation*, in the form of anchylosis. The fibrous state represents the incomplete result of reparation; the osseous state, its completion, by the transformation of the fibrous matrix into bone. The co-existence of *necrosis* with anchylosis is rare. But in the following case, a sequestrum of cancellous tissue in the head of the femur, with destruction of a central portion of the articular cartilage, is associated with *fibrous* anchylosis of the hip-joint. (Fig. 427, vertical section.) Just in front of the anterior inter-trochanteric line, an opening through the cancellous tissue gave vent to purulent discharge by a fistulous abscess, which

FIG. 427.†

* King's Coll. Mus., 1125. † St. Thomas's Hosp. Mus., D. 49.

ran behind the tendon of the rectus muscle to the outer side of the thigh. (See also "Path. Trans.," 1851–52, p. 427.)

Treatment.—Preventive measures consist in the prompt and efficient treatment of the diseases leading to anchylosis; while the precaution should also be taken of securing the limb in such *position* as shall be most useful in the event of this result.

Remedial treatment consists in restoring, if possible, the mobility of the joint, and correcting any deformity of the limb. Or the latter may be the main object in view.

Fibrous anchylosis—admitting of some motion in the joint—commonly yields to passive motion, from time to time; thereby gradually regaining the use of the joint. Firmer union will probably have to be overcome by *extension;* either gradually applied by means of some mechanical apparatus, or by *forcible* manipulation, in the way of flexion and extension, under the influence of chloroform. The former method may have to be continued for a period of from one to three months, according to the resistance of the anchylosis, and the size of the joint, as in the case of the knee. In the latter method of extension, the joint yields with a creaking cleavage and successive snaps, which are both heard and felt. The rectification of deformity, thus gained, must be secured by the application of a properly adjusted retentive instrument or splint; passive motion also being practised occasionally. Extension-treatment will generally prove sufficient, but any resisting tendons may be divided subcutaneously, tenotomy completing the cure. In such case, the extending splint should be so adapted that, according to the rule respecting the after-treatment of tenotomy, the limb shall remain at the same angle in which it was prior to division of the tendons, until the punctures have healed,—about the fourth day; when extension may be commenced. The knee, hip, or elbow joints, for example, can thus be restored to a fair degree of mobility, and the limb brought to a good position. A too sudden or instantaneous, as well as forcible, flexion and extension of a fibrous anchylosis, is liable to be attended with severe injury, either by fracture of the articular ends of bone, dislocation, or rupture of the adjoining blood-vessels and nerves; or it may be followed by inflammation, suppuration, gangrene, or pyæmia. When these mechanical or manipulative and perhaps operative procedures have failed, if then the fibrous anchylosis be incompatible with a good use of the limb, as in the case of such anchylosis of the knee-joint, *excision* of the joint may be advantageously resorted to; and the more so, in proportion to *mal-position* of the limb.

Osseous anchylosis cannot be overcome by any justifiable force of extension. But the propriety of operative interference will depend on the comparative inutility of the limb; whether owing to the kind of anchylosis, as in regard to the elbow-joint, or mal-position of the limb, as may be the case in the knee-joint. *Subcutaneous section* or *drilling* of the *anchylosis*, as an operation appropriate for osseous anchylosis of the knee, was originally proposed by Brainard, and performed successfully by Pancoast, Langenbeck, and Gross, and in this country by Mr. Stromeyer L. Little. This procedure consists simply in making a small puncture or incision opposite the junction of the articular cartilages, and the introduction of a narrow sharp-cutting gouge, or a gouge-drill, which is driven between the ends of bone in different directions, so as to weaken their connection,

and allow the limb to be straightened by gentle manual extension, aided perhaps by tenotomy of the hamstring muscles. Subcutaneous section of the bone in the *vicinity* of an anchylosed joint, offers another resource, at least with regard to the hip-joint; as in Mr. W. Adams's operation—by division of the neck of the femur, subcutaneously; Dr. Rhea-Barton's and Dr. Sayre's operations—by section through the trochanters; or the operation which I proposed—section of the femur just below the trochanters. This procedure I have practised in two cases, and with successful results. *Excision* becomes justifiable after subcutaneous division has failed, or when that operation would be inappropriate to correct mal-position of the limb. Thus, the removal of a wedge-shaped portion of bone, including an anchylosed joint, may be necessary to rectify an angular deformity of the limb, in the case of the knee-joint; a mode of excision introduced by Birch, of New York, and which I have practised with considerable success. Dr. Rhea-Barton had previously proposed another mode of excision, under these circumstances—the removal of a wedge of bone from just *above* the condyles of the femur, and not quite including their entire diameter; the remaining portion of bone is then fractured by bending the limb backwards, so that the limb could be straightened. But the former angular position was retained at first by means of a corresponding splint, and the limb gradually extended before the period for bony union. *Amputation* will be warrantable only in the extreme case of a useless limb, and which cannot be made tolerably serviceable by excision.

Loose Cartilages in Joints.—Small movable bodies occasionally form within a joint, and which may be quite free, or attached by narrow peduncles to the walls of the articular cavity. One such body sometimes exists, but not uncommonly two or three, and possibly many. In the left knee of a woman who died of apoplexy, Morgagni found twenty-five smooth and polished globular bodies. Varying in size from a barley-corn to a chestnut, they are roundish or flattened, elongated or tuberous. In consistence, colour, and structure, these bodies may be soft and of a yellowish colour, like little melon-seed masses of fibrine; or hard, whitish, and glistening, consisting of cartilage or fibro-cartilage; or converted into bone. Neither the term "cartilage" nor "loose" is, therefore, universally applicable.

Fig. 428.*

Any joint possibly may be the seat of these bodies; but they occur usually in the knee, and less frequently in the elbow, shoulder, or lower jaw.

They seem to *arise* from the vascular processes of the synovial membrane, as out-growths of that membrane, projecting into the joint. (Fig. 428.) They remain connected, or become detached, and are liable to undergo the changes of appearances and structure above

* St. George's Hospital Mus., 111, 9. Synovial membrane of the knee-joint, exhibiting numerous excrescences, filiform or pedunculated, growing from the internal surface of the membrane. These bodies are of a yellowish white colour, and would appear to contain much fatty tissue. History of the case unknown. (B. C. Brodie, from "Heaviside's Museum.")

described. These cartilaginous bodies form most frequently as the result of chronic rheumatic synovitis; and more often in adults than at an earlier period of life. Billroth's observations point to the ligamentous capsule as the most frequent source of these ossifying cartilages, which may enter the joint, and become free. Rarely, they form in the synovial tufts. Other modes of origin seem probable in some cases. Thus, the fibrinous concretions may, perhaps, represent exudations, or precipitations from the synovia. Portions of bone becoming detached from the articular surfaces, or resulting from ossific deposit, give rise to similar symptoms.

Symptoms.—It will be readily supposed that any such foreign body getting nipped in between the articular surfaces, must occasion some remarkable symptoms. Hence, an attached cartilaginous body may remain quiescent; a detached, or entirely loose cartilage, moving about in the synovial capsule, is more apt to slip in between the bones. Up to this time the patient may have experienced occasional twinges, as if of rheumatic character; but now a sudden, intense, and sickening pain seizes him; and the joint becoming instantly locked, the hitching or fixed inability to move the limb may throw him to the ground in the act of progression. Sudden dislodgment of the intervening cartilage is equally apt to occur, whereby the joint is immediately restored to its original state of painless mobility; leaving only perhaps a little temporary effusion. These symptoms having recurred at intervals, on the slightest movement, and sometimes during sleep, the sufferer seeks relief. On careful examination, a foreign body can usually be found, and by palpation brought perhaps to a stand-still at the edge of the patella—in the knee-joint, and there made to bulge under the skin; or the patient can, perhaps, himself make the movable body perceptible, by a jerking movement of the joint; but the little smooth cartilage easily slips away from under the finger, and again disappears.

Ultimately, the joint itself sometimes become diseased; prolonged irritation inducing synovitis, with relaxation of the ligaments, which are loosened also by having been stretched by the repeated interposition of the cartilage between the articular surfaces.

Treatment.—Recurrence of the attacks of pain may be prevented by limiting the motions of the joint; thus fixing the loose cartilage temporarily, or perchance permanently. Hence, an elastic bandage or knee-cap should be constantly worn. Often the relief afforded is such that no further interference becomes requisite.

Removal of the foreign body is the only other resource; but this should never be lightly entertained, considering the risk to the joint and even to life, contingent on the operation of extraction. It is justifiable only when the cartilaginous body is loose, and freely movable, of some size, and apparently single. Taking a favourable opportunity—after the pain and irritation of an attack have subsided—this operation may be performed, in either of three ways. It is more difficult than would appear to one who has not done it. The cartilage must first be carefully fixed, in a steady spot, with the forefinger and thumb. In the knee, it may be made to project on one side of the patella. The skin is then to be drawn to one side, and an incision made *directly* down upon the cartilage, which is thence allowed to *escape*. On relaxing the skin, the valvular aperture is at once closed with a strip of plaster, and the limb should be kept at rest until any symptoms of synovitis have sub-

sided. In this way I removed a loose cartilage, the size of a shilling, but twice as thick, from the left knee-joint of a young man. Slight synovitis only followed the operation; this was subdued by rest, and an ice-bag, with a perfectly successful result,—the joint remaining strong and freely movable.

Another mode of operation consists in introducing a tenotomy knife *slantingly* underneath the skin, and dividing the synovial capsule upon the fixed cartilaginous body; then, squeezing it through the synovial aperture into the external cellular texture, where it is allowed to *remain*, the integumental aperture is closed with a strip of plaster. If the cartilage should not become absorbed, it is extracted from its bed by a *subcutaneous* incision, when the synovial aperture has healed, after the lapse of some days.

Both these methods of operation are hazardous; but the subcutaneous one is less so than the immediate mode of extraction, as would appear from a large number of cases the results of which were compared by M. Larrey. In 167 cases of removal of loose cartilages by operation, 121 were cases of the direct operation, and 98 were successful, 5 doubtful, and 28 died; whilst of 39 subcutaneous operations, 19 were successful, 15 failed, and 5 died.

A modification of the subcutaneous operation has been practised by Mr. Square, of Plymouth; and by which Mr. Erichsen states that he has successfully removed in succession five loose cartilages from one knee. The capsule having been divided subcutaneously over the fixed cartilage, it is pressed *into*—not through—the synovial aperture, and retained there by a compress and strips of plaster. Adhesion speedily ensues, followed by absorption of the cartilage.

Mr. Syme recommends yet another method, by which, he says, he generally succeeds without risk. It consists in "making a free subcutaneous incision through the synovial membrane and cartilage, and applying a blister over the part where it is retained."

TUMOURS CONNECTED WITH JOINTS.—*Cancer* of the *Articular* ends of Bone is sufficiently described in connection with Cancer of Bone generally. "In *cartilage*," observes Virchow in his "Cellular Pathology," "malignant affections are so rare, that it is usually assumed to be altogether insusceptible of them." The *synovial membranes* are equally indisposed to cancerous disease. Sir B. Brodie states that he had "no reason to believe that any truly malignant disease ever has its origin in the synovial membrane."

For other Morbid Growths in the articular ends of Bone, see TUMOURS OF BONE.

NEURALGIA OF JOINTS is specially important in relation to the *diagnosis* from structural disease. See Affections of the NERVES.

CHAPTER XXXVII.

DISEASES OF PARTICULAR JOINTS.

DISEASES OF THE HIP-JOINT.—The hip-joint is liable to the same inflammatory diseases as other joints, affecting its component structures: synovitis, scrofulous caries, and ulceration of the articular cartilages. The second-named disease presents characters worthy of a separate description.

SCROFULOUS DISEASE OF THE HIP, OR MORBUS COXARIUS.—*Structural Conditions.*—This disease commences in the *cancellous tissue* of the head of the *femur*, or of the *acetabulum;* possibly, in both bones simultaneously. It may also commence in the synovial membrane, as scrofulous synovitis; or, it is said, in the round ligament. Hence the name scrofulous *disease* of the hip, as a general term including these different *seats of origin.*

In scrofulous caries of the hip, the cancellous tissue undergoes the

FIG. 429.*

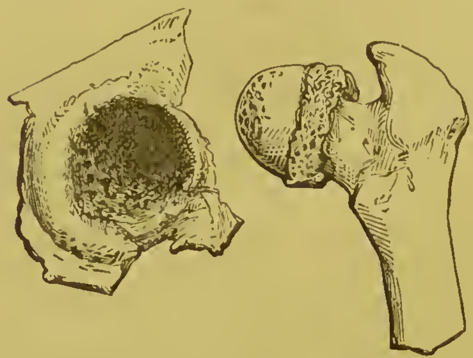
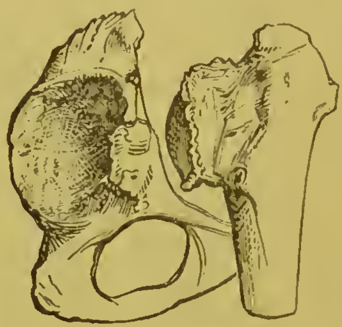
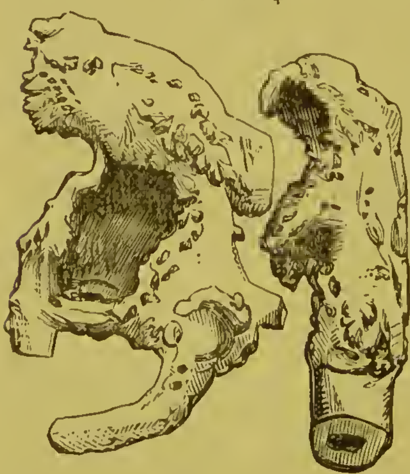


FIG. 430.†



structural alterations described in connection with this disease of Bone; briefly, increased vascularity, softening, deposition of a reddish fluid in the enlarged cancelli, followed by a yellowish opaque tubercular matter.

FIG. 431.‡



Subsequent structural alterations are as follow:—The *articular cartilages* become involved and disappear, more or less completely; and abscess forms within the cavity of the joint. The affected portions of bone become remarkably changed in shape and size. The *head* of the femur—bared, perhaps, of cartilage, and the open cancellous tissue exposed—is flattened and expanded, mushroom-like in form on the neck of the bone (Fig. 429); and the *neck* itself, sharing in the disease, may be so reduced as to leave nothing more than a slight nodular vestige, if any remnant, of the diseased bone projecting from the great trochanter. (Fig. 430.) This portion of the

* St. Bartholomew's Hosp. Mus., B. 7. † Ibid., B. 8. ‡ Ibid. B. 10.

bone, and the adjoining portion of the shaft, are not unfrequently carious; either by an extension of the joint-disease, or as the original seat of caries. The *acetabular cavity*, also denuded of cartilage, is enlarged in circumference, but shallow; the cotyloid ligament and bony rim of this cavity having been destroyed. The *round ligament* may have disappeared, and the *capsular ligament* at length giving way, the abscess bursts into the surrounding cellular texture. Thus, the joint is utterly destroyed.

Terminations.—(1.) *Anchylosis* rarely takes place, as a mode of reparation. (2.) The remnant of the articular end of the femur is drawn up by the action of the muscles into the patulous acetabulum. Thence the femur has even been forced through the thin carious bottom of this cavity, and *entered the pelvis.* (Fig. 432.) (3.) But the ill-fitting, loose articulation, from advanced disease, is mostly liable to *dislocation.* The femur, drawn upwards and outwards by the glutei muscles, passes over the reduced brim of the acetabular cavity, and slipping on to the *dorsum ilii*, lodges there. More rarely, the femur is thrust out of the acetabulum forwards, and rests on the *ramus* of the *pubes. Abscess* finds its way to the surface by burrowing sinuous tracks, and opens in various situations. The openings relate somewhat to the seat of the disease. When it originates in the head of the femur, the sinus extends some way down the thigh, and opens probably near the insertion of the tensor vaginæ femoris muscle. Acetabular disease presents a sinus-opening in the gluteal region, near the anterior inferior spine of the ilium. Matter may also pass down by the rectum, bursting into it, or close to the anus. If the pelvic bones be involved, a sinus-opening is presented in the pubic region, above or below Poupart's ligament; above the ligament, it leads probably to intra-pelvic abscess; below the ligament, to disease of the rami of the pubis or ischium.

Fig. 432.*

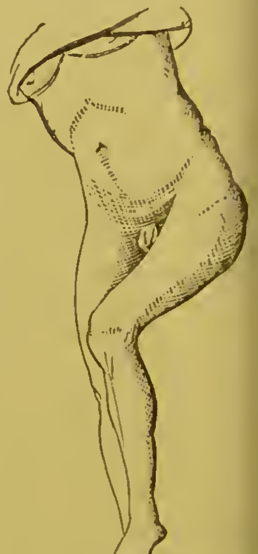
Signs.—(1.) Scrofulous disease of the hip-joint approaches and progresses very insidiously. Commencing generally in early life, under the age of puberty, scarcely any pain—but what the mother will call "growing pain"—is complained of in the first instance, or for weeks, possibly months, as the disease slowly progresses. The first perceptible sign is a *slight limp* in walking; the child shuffling, hobbling, or dragging his leg, step by step. When standing still, the whole weight of the body is thrown on the other limb, to relieve the halting member. This *attitude* is peculiar; the hip of the sound limb being elevated, gives an obliquity to the pelvis downwards on the diseased side; the thigh is slightly bent on the pelvis, and the leg on the thigh, the toes touching the ground. The limb may be somewhat abducted and everted, the toes being turned outwards; in this particular resembling dislocation on the pubes, or fracture of the neck of the femur. But in the *first stage* of diseased hip-joint, the limb is *apparently elongated.*

* St. Bartholomew's Hosp. Mus., B. 14.

(Fig. 433.) This, however, is a deceptive appearance, arising from the obliquity of the pelvis downwards towards the diseased hip; measurement with a tape from the anterior superior spine of the ilium to another fixed point below the joint, the inner malleolus, will at once show that there is no elongation in reality. The limb becomes *wasted* from disuse, the gluteal muscles especially, so that the buttock is flattened and flaccid, wider than natural, and the lower fold of the nates less marked. *Pain* is now felt in the hip, or referred more to the inner side of the knee; and the pain in the former situation is aggravated by any attempt to bear on the joint, by abduction or rotation of the limb, and especially by concussion of the bones, as by striking the trochanter or jerking the limb upwards from the sole of the foot. Pain on the inner aspect of the knee is a sympathetic sensation; depending, probably, on the nervous relation between the hip and knee, through the obturator and perhaps the anterior crural nerves. Both these nerves supply articular branches to the hip, and to the inner side of the knee.

Fig. 433.*

Fig. 434.†



(2.) *Real shortening* of the limb—succeeding its apparent lengthening—marks the *second stage*, as it has been termed, of this disease. It coincides with advancement of the disease to *destruction* of the *cartilages* and of the head of the femur, acetabulum, or both bones; whereupon the limb is drawn up by muscular action. Shortening varies, therefore, in different cases, but it increases as the disease progresses. The *attitude* of the limb is somewhat changed; still remaining flexed, it has now also become *inverted*, with some projection of the buttock backwards and upwards; in these appearances resembling dislocation backwards on the dorsum ilii or into the ischiatic notch. Lateral inclination of the pelvis has at length produced a compensatory *lateral curvature of the spine*, in the lumbar region; with more or less incurvation or lordosis, owing to the uprising of the buttock. Wasting of the limb increases. This shortened, flexed, inverted, and wasted limb, with obliquity of the pelvis and twisted lordosis of the spine, presents a very characteristic appearance. (Fig. 434.) Pain also has become more severe, and aggravated by the attrition of the exposed surfaces of bone, subject to spasmodic muscular action, has acquired the character of *starting pains*.

Abscess within the joint bursts into the surrounding cellular texture.

* Royal Free Hospital. From a boy, aged 16. Disease of about six months' duration. (Author.) † Another case. (Author.)

and forms a swelling in connection with the hip, which up to this time has undergone no further alteration than a slight fulness in the groin, and enlargement of the inguinal glands. Abscess-swelling is rendered more conspicuous by the wasting of the thigh and buttock. When, at length, the abscess opens externally, the situation of the *sinus apertures* denotes, as already indicated, the probable seat of the disease; whether in the head of the femur or acetabulum. *Dislocation* is very apt to supervene, commonly on the dorsum ilii; yet, although attended with increased shortening, the attitude of the limb, flexed and inverted, remains the same. But the head of the femur or its remnant, with the great trochanter, can be felt in its new situation, on the back of the ilium; and often very distinctly, the gluteal muscles having wasted so much that the bone seems to lie immediately under the skin. (Fig. 435.) The additional symptoms—wasting of the limb, and sinuses discharging an unhealthy pus and leading down to diseased bone—complete the local diagnostic differences of appearance from *traumatic* dislocation. The general health also has now become worn down by irritation and hectic; and this constitutional condition, coupled with that of the diseased limb, form a picture which leaves little or no doubt as to the nature of the case, not to mention the previous history of its insidious origin.

FIG. 435.*

In order the more clearly to contrast the signs of hip-joint disease, in its first and second stages, I have here appended the following tabular view from Bauer (the second and third stages according to his description and that of Sayre; the first stage corresponding to limping lameness):—

FIRST STAGE.	SECOND STAGE.
Limb apparently longer.	Limb shorter.
„ abducted.	„ adducted.
„ everted.	„ inverted.
„ flexed in both joints.	„ flexed in hip-joint only, possibly at knee-joint also.
Foot touches the ground with sole.	Foot touches with ball only.
Toes everted, as in fracture of neck.	Toes inverted as in dislocation on dorsum ilii.
Pelvis lowered on diseased side.	Pelvis raised.
„ projected forward.	„ projected backwards.
„ angle of inclination acute.	„ angle of inclination almost right.
Natis low and flat.	Natis high and round.
Linea inter nates inclined towards affected side.	Linea inter nates deviated from affected side.
Pain most intense.	Pain greatly diminished.

Diagnosis.—Scrofulous disease of the hip-joint is liable to be mistaken for other diseases, if *any one* particular symptom be alone considered. It may resemble traumatic dislocation on the dorsum ilii, congenital dislocation of the hip-joint, infantile paralysis with wasting and defective growth of the limb, sprain of the hip-joint, interstitial absorption of the neck of the femur, rheumatism, disease of the knee,

* Royal Free Hospital. (Author.)

lateral curvature of the spine, psoas abscess, abscess near the joint, inflammation of the bursa under the psoas-iliac muscle, or of the bursa over the great trochanter, trochanteric periostitis or ostitis. But the *concurrence* of symptoms, and as compared with those of each of these diseases, will terminate the diagnosis. Thus, the distinction of hip-joint disease from *dislocation* of the femur on the dorsum ilii, has already been adverted to in this light. If the shortening, flexed and inverted attitude of the limb, as two signs of hip-joint disease, be taken alone, it might so far resemble dorsal dislocation, apart from the concurring signs of a wasted appearance of the limb, coupled with obliquity of the pelvis, and twisted lordosis of the lumbar spine, all of which signs are absent in dislocation on the dorsum ilii. When dislocation has taken plaee from disease, the additional signs of abseess, generally in the buttock, followed by sinus-openings in the situations already noticed, are diagnostic. The history of the case, as having the progressive character of disease, or as one of sudden violent injury, must always be further taken into aceount.

In young subjects, however—in whom disease of the hip-joint is more commonly met with—*congenital* dislocation of this joint is more likely to be the question of diagnosis. The joint is imperfcetly developed; and the loose gait of the child attraets attention, the movements are painless, and the dislocation is readily reduced, but it as easily returns,—the small, stunted femoral head slipping in and out of the shallow, misshapen acetabulum, being unseeured by a round ligament, and not restrained by the large and incomplete capsule. *Infantile paralysis*, with wasting and defective growth of the limb, will also be recognized as a peeuliar affection, in relation to the differentiation of hip-joint disease.

Sprain of the hip-joint simulates disease of the joint so far as to be attended with a painful, limping lameness; the hip is raised and the limb flexed, perhaps everted; and in the course of time, there may be more or less wasting of the buttock and thigh; all these symptoms arising from the pain provoked by any attempt to use the limb, in standing or walking. But, while the pain is more aeute than that which the patient complains of in the early stage of hip-joint disease, the hip is raised, as if the limb were shortened on the affected side; and in a later stage of sprain, the limb still retains its natural length,—there is no real shortening. Here, also, the antecedent history of an injury will enter into the Surgeon's consideration of the case, but as a less important factor; for a sprain might give rise to disease of the hip-joint.

Fig. 436.*

Interstitial absorption of the neck of the femur might readily be mistaken for disease of the hip-joint. Arising from a fall on the trochanter, absorption of the neck of the bone proceeds slowly, and is attended with shortening of the limb. But the inverted position, seen in disease of the joint, is wanting to complete the resemblance. Pathologically considered, the state of the part is very different, interstitial absorption of the neck being

* From Liston.

unattended with any destruction of the articular cartilage, which still caps the head of the bone. Otherwise, a section (Fig. 436) has the flattened, stunted appearance resulting from progressive destruction of the head and neck.

Rheumatism of the hip-joint may be an acute or chronic affection. An *acute* attack of rheumatism will rarely settle in the hip-joint, as rheumatic synovitis, leaving other joints unaffected. The co-existence, therefore, of similar symptoms in other parts, will at once distinguish such an attack from scrofulous disease of the hip-joint. But the intense character of the pain, and tender, tense swelling in the groin, behind the great trochanter, or in both situations, are unlike the more passive state of the joint, in an early stage of caries. Chronic rheumatic arthritis or synovitis, when limited to the hip-joint, certainly bears a general resemblance to scrofulous disease of the joint, in a more advanced stage. But here, again, the character of the pain is even more distinctive; an aching, boring, gnawing pain, increased by motion, yet wearing off somewhat by exercise during the day, worse at night, and aggravated by exposure to variable climatic changes of cold and moisture. The irregular enlargement or deformity of the joint, from nodular ossific deposit, may not be so palpable as in rheumatic arthritis of other joints, as the knee; but the peculiar rigidity or stiffness, and crackling or grating sound on moving the joint, can scarcely be overlooked in the examination. The patient's age will also be considered; although acute rheumatism may occur in childhood, chronic rheumatic arthritis is usually a disease of mid-life.

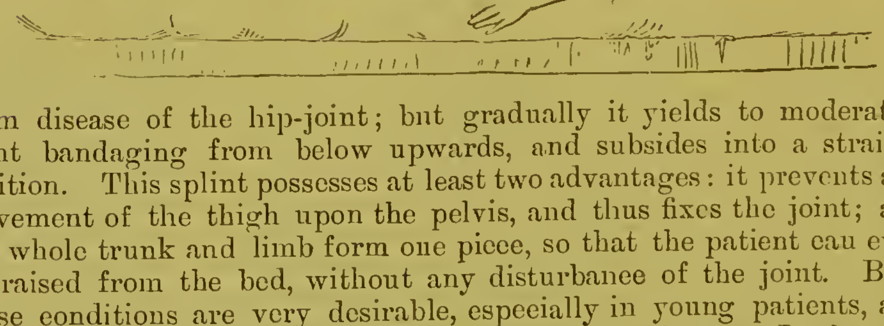
Disease of the hip-joint might be mistaken for disease of, or originating in, other parts, if the Surgeon's attention were directed exclusively to any one symptom.

Thus, the pain in the inner side of the *knee* might be referred to disease of that joint; unless the association of the other symptoms or signs of hip-joint disease be observed, and the absence of the characteristic swelling of synovitis, or of scrofulous caries, as affecting the knee-joint. But the possible co-existence of disease in both the hip and knee joints should not be forgotten as an occasional association. *Lateral curvature* of the spine is attended with obliquity of the pelvis, corresponding to the lumbar curve; the pelvis being raised on the side of concavity, and lowered from the opposite convexity. Yet there are no other signs of hip-joint disease. *Psoas abscess* presents a swelling, often of considerable size, in the groin,—an exaggerated appearance of the fulness seen in disease of the hip-joint. But this swelling can be reduced or returned into the abdomen by compression, aided by the recumbent position; and it has a marked impulse when the patient coughs or makes any straining effort; in both these respects differing from any inguinal fulness in connection with the hip-joint. Abscess *near* the hip-joint, but unconnected, may be extra-pelvic or intra-pelvic; and in either case, the diagnosis must be determined by a thorough examination around the joint, and by rectal exploration, coupled with palpation through the abdominal wall. *Enlargement* of the *bursa* under the psoas-iliac muscle forms a swelling in that situation, distinct from the capsule, when the two do not communicate; and the movements of the hip-joint are free and painless, except when the muscle is stretched by extension and rotation outwards of the thigh. More often, I think,

there may be an enlargement of the bursa over the *great trochanter;* the painful swelling, in this case, being more plainly defined, and limited to the trochanter. *Periostitis* or *ostitis* of the great trochanter resembles disease of the hip-joint; excepting in the more superficial seat of pain, and which is not aggravated by any movement of the joint itself, or by weight-bearing pressure, or by concussion upwards from the sole of the foot, nor is there any sympathetic pain on the inner side of the knee. No shortening of the limb results, as in a more advanced stage of hip-joint disease. Trochanteric disease *co-existing* with that of the joint no longer offers any ground for diagnosis; and, practically, no distinction is necessary.

Treatment.—The directions given with reference to scrofulous disease of the joints generally are here applicable, rendering any repetition of detail unnecessary. Absolute rest of the joint must be secured, and a position favourable to the future use of the limb, in the event of anchylosis. A splint moulded to the hip and extending below the knee, with the limb straightened, may answer this twofold purpose. In the second stage of disease, the long, straight, *extending* splint may be applied with more advantage; thus to counteract muscular spasm and pain coincident with ulceration of the cartilages in contact, and the liability to dislocation as the disease advances. But simple weight-extension from the foot is the mode of treatment I now generally prefer; and the successful results thus obtained are undeniable. A very useful splint has been devised by Mr. Thomas, of Liverpool. It consists of a metallic bar-support, extending underneath the limb, from about the middle of the calf to the middle of the back, the leg and thigh portion being straight, while the upper portion is bent to the form of the buttock and loins. (Fig. 437.) This is fastened by straps across the thorax, and further secured by a shoulder strap. When the limb is first placed in this splint, it may be allowed to remain bent, as

Fig. 437.



from disease of the hip-joint; but gradually it yields to moderately tight bandaging from below upwards, and subsides into a straight position. This splint possesses at least two advantages: it prevents any movement of the thigh upon the pelvis, and thus fixes the joint; and the whole trunk and limb form one piece, so that the patient can even be raised from the bed, without any disturbance of the joint. Both these conditions are very desirable, especially in young patients, and who are more frequently the subjects of hip-joint disease. In the case I have represented, a girl, who was thus treated by me in the Royal Free Hospital, experienced great relief from pain, after the ordinary long, straight, external thigh-splint had been used for some time. Subsequently, however, the disease advanced to the formation of abscess,

and I had recourse to excision of the joint. The same splint was reapplied in the after-treatment; but discharge from the wound having a tendency to soak in between the buttock portion of the splint, I was compelled—for the sake of cleanliness—to return to the external, interrupted thigh-splint. In the treatment, by means of Mr. Thomas's splint, weight-extension from the foot can be as readily applied.

FIG. 438.

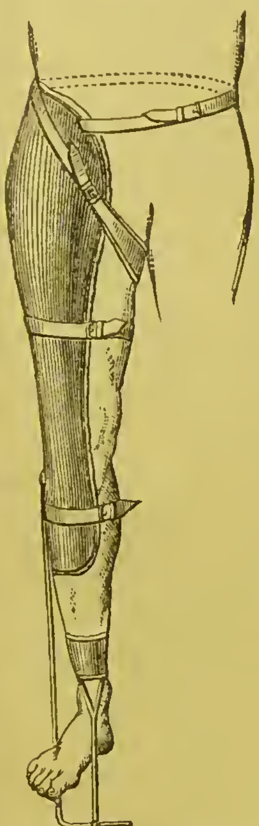
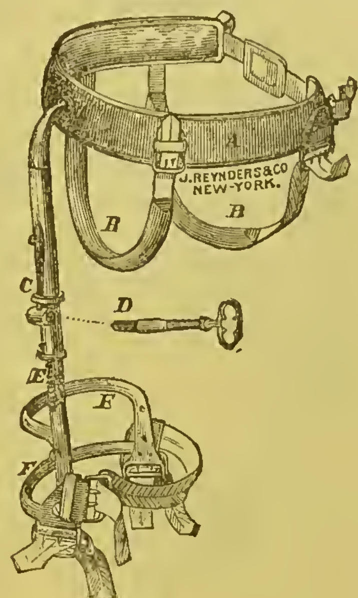
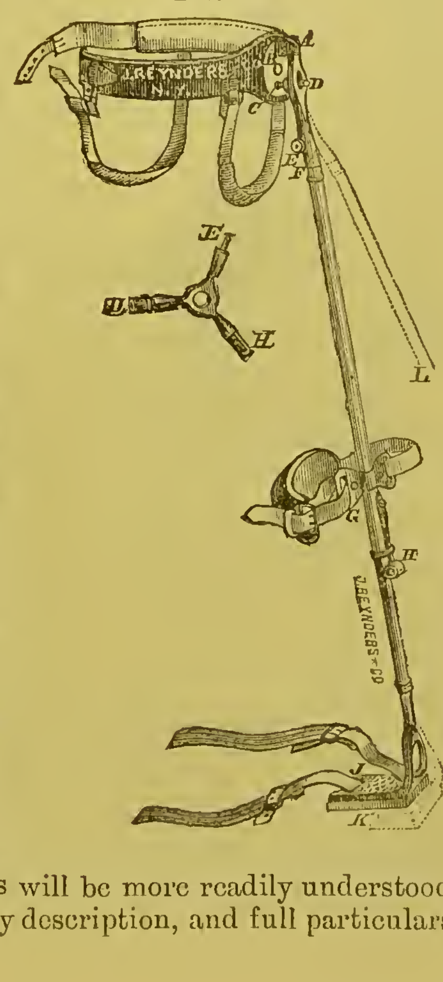


FIG. 439.



Extending apparatus of various kinds are more or less in use for the treatment of hip-joint disease. I have not yet had any experience of the advantages they are said to offer. The accompanying form of such apparatus is a combination of the leathern hip-splint advocated by Sir B. Brodie, with Dr. Davis's metallic lever (Fig. 438); but the simple manner in which it is made to control any rotative or abducting movement of the limb is peculiar.

FIG. 440.

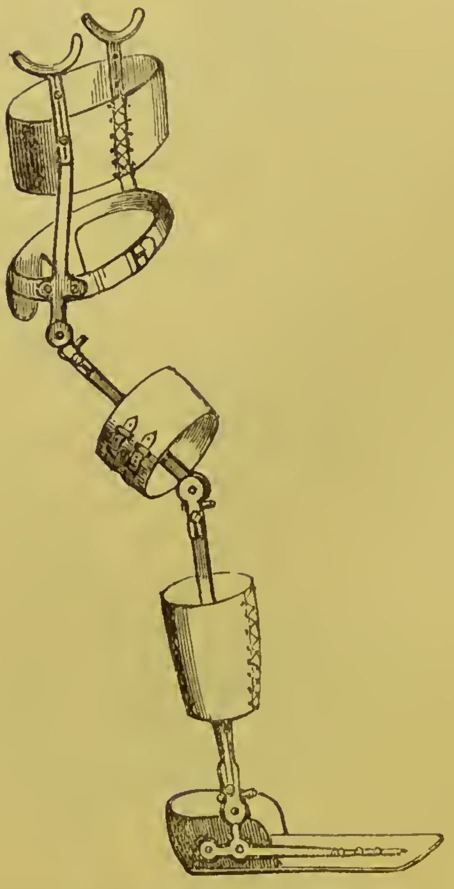


Dr. Sayre, of New York, has called our attention to two splints, a short and a long one, which he commonly employs. These splints are here represented. (Figs. 439, 440.) They are designed to allow the patient to move about, and thus to have the benefit of exercise in the open air, for the maintenance or restoration of the general health. Such splints, therefore, are eligible only in an early and slight stage of hip-joint disease, or during convalescence from the more advanced stage. The construction of these rather complicated forms of apparatus will be more readily understood by personal examination than from any description, and full particulars

as to their elaborate methods of application will be found in Dr. Sayre's "Lectures on Orthopedic Surgery and Diseases of the Joints," 1876, p. 262.

Contraction of the hip—as the result of joint-disease—may be counteracted by the annexed apparatus (Fig. 441), which successfully combats each abnormal malposition of the limb. The pelvic band bears two lateral uprights, upon which the armpits rest, and from which strong laced bands pass around the thorax. This instrument is especially adapted for cases of severe hip-contraction.

Fig. 441.



Abscess should be opened to prevent burrowing of the matter among the muscles. The situation of pointing is selected, usually about an inch above and behind the great trochanter. For the convenience of dressing, a long "interrupted" splint may be used. The general treatment, medicinal and hygienic, consists in a course of iron, quinine, cod-liver oil, and nutritious diet, with as much pure air as possible. I have very beneficially placed my hospital patients in bed in the quadrangle of the hospital, for some hours daily, weather permitting.

This plan of treatment must be pursued for a considerable period—some weeks or months—to solicit anchylosis; or the subsidence of the disease, possibly, after dislocation, and a free discharge of matter with the detritus of the carious bone.

Failing thus to bring the disease to a termination, and the general health beginning to decline, operative interference becomes imperative. This will be considered under Excision of the Hip.

CHRONIC RHEUMATIC SYNOVITIS OR ARTHRITIS.—MORBUS COXÆ SENILIS.—*Structural Condition.*—This disease contrasts with scrofulous disease of the hip-joint, principally in the formation of osseous depositions or outgrowths around the joint, and in the absence of suppuration.

Signs, and Diagnosis.—Commencing with stiffness and aching pains in the joint, both of which are somewhat relieved by exercise, at length a grating attrition, which can be both felt and heard when the joint is moved, affords characteristic evidence of the disease; coupled with its *dry* character,—the absence of suppuration in the joint, and its consequences,—the swelling of abscess and the discharging sinuses which would ensue in scrofulous disease. Shortening of the limb to some extent occurs, as destruction of the articular cartilages takes place, with expansion of the head of the bone, and

lowering of its neck to even below the level of the great trochanter. The limb is drawn up, the thigh and buttock are wasted; the patient stands on the other limb, and walks with a limping lameness.

The disease progresses slowly, for years; clearly distinguishing it from the sudden result of fracture. Other articulations being or becoming affected, would leave no doubt as to the nature of the hip-condition. Thus, the finger-joints are often attacked, being greatly deformed with nodulated chalk-stones; while the ball of the great toe is frequently much enlarged, and the joint partially dislocated inwards. The general health is often little disturbed, the disease appearing as a local affection. Males are attacked far more often than females, and thin persons mostly. Chronic rheumatic arthritis, affecting the hip-joint, seldom occurs under the age of forty; differing in this respect from scrofulous disease of the joint, as well as in its pathology and symptoms.

Treatment.—See Chronic Rheumatic Synovitis.

NEURALGIA of the Hip.—The *diagnostic* Symptoms of Neuralgia are pointed out in connection with affections of the NERVES.

Neuralgia of some duration is attended with the alterations of attitude consequent on disease of the joint—whether scrofulous or rheumatic. The weight of the body being habitually thrown on the sound limb to relieve the affected joint of the other side, the limb on *this* side becomes apparently lengthened and flexed, the toes touching the ground; the pelvis is inclined obliquely to the same side, and some compensatory lateral curvature of the lumbar spine results. But, with neuralgia, no real *shortening* of the limb ever ensues.

DISEASE OF THE SACRO-ILIAC JOINT.—*Structural Condition.*—The cartilaginous lamella of the sacro-iliac articulation seems to be the seat of a disease, occasionally affecting this joint. Ulceration of the cartilage, as the primary change, involves the synovial membrane; both of which structures are thus destroyed more or less completely. But the ligaments remain unaffected, or are only partially destroyed; and the adjoining osseous surfaces seldom become carious or necrosed. This disease is of very rare occurrence. It may be associated with extensive disease of the hip-joint. (Fig. 442.) In the sacro-iliac joint here shown, are two large cavities containing pieces of necrosed bone, not quite detached; and above there is a small cavity on the inner surface of the ilium, which contained scrofulous matter. This disease occurred in a man aged twenty-three; and the symptoms of hip-joint disease were well marked. Numerous abscesses formed in various situations, and discharging very profusely, the patient died from hectic exhaustion.

FIG. 442.*

Signs, and Diagnosis.—*Pain* is one of the earliest symptoms. It is confined to the region of the joint, and increased by any movement or position whereby the weight of the body is thrown upon the sacro-iliac joint. Thus, walking, stooping, or even standing, is attended with a

* St. George's Hosp. Mus., 111, 93.

sense of painful weakness in that situation, and as if the body were falling asunder. When the pelvis is at rest, or fixed in the recumbent position by the hand of the Surgeon, for examination, the *hip* may be moved in any direction without pain. It acquires a gnawing or rheumatic character as the disease advances. Sometimes the pain extends down the limb; or in that of the opposite side, as proceeding from the pressure of an intra-pelvic abscess lying on the sacral plexus. Inability to support the weight of the body occasions an insecure, *wriggling gait*, from side to side. There may be the additional symptoms of some difficulty in micturition and defecation. *Swelling* makes its appearance over the joint; it is pulpy and elastic, and of an elongated shape in the line of the articulation. The limb is *apparently elongated*, owing to a drooping of the pelvis on the diseased side, the limb being disused to support the trunk; and this side of the pelvis is tilted forwards. Consequently, the anterior superior spine of the ilium is both on a lower level and more prominent forwards, than on the sound side. Measurement, however, from that prominence to the inner malleolus shows that the limb is not elongated; that any apparent lengthening—say, half an inch—is not due to any change in the three large joints, or in the bones of the limb; but that it must depend on some alteration *above* the anterior superior spine. Usually, the limb is *straight*, and becomes *wasted* as the disease progresses.

Abscess occurs at a late period. It forms over the diseased articulation, but spreads in various directions. The matter may point posteriorly near the articulation, passing upwards perhaps to the loin, upon and just above the crest of the ilium, there forming a fluctuating swelling of considerable size; or extending outwards over the buttock, it reaches forwards nearly to the trochanter, as a great gluteal abscess. In both these situations, lumbar and gluteal, the abscess is *extra-pelvic. Intra-pelvic* abscess, the matter accumulating within the pelvis, may pass out of the sciatic notch, and thence under the gluteal muscles; or gravitate downwards into the ischio-rectal fossa, and present by the side of the rectum, or vagina; or open into the rectum and discharge per anum. *Shortening* of the limb takes place, in consequence of, and proportionate to, the destruction of the sacro-iliac articulation. In one case, related by Sir B. Brodie, the ilium seemed displaced and drawn upwards, so as to shorten the affected limb by two inches.

The *diagnosis* will have to be made between this disease, and that of the hip, disease of the pelvic bones, spinal disease, neuralgia of the hip, and sciatica.

As compared with disease of the *hip-joint*, sacro-iliac disease differs more or less notably in nearly *all* the symptoms: the loose, wriggling gait, rather than dragging lameness of the limb; the early accession of pain, and its situation—in the sacro-iliac joint, with the absence of pain in the hip-joint and the sympathetic sensation on the inner side of the knee. The swelling which supervenes corresponds to the articulation which is affected. Observing these signs as relating to the seat of the disease, the Surgeon will not be misled by certain features of resemblance to disease of the hip-joint—in the apparent lengthening of the limb on the affected side, accompanied with downward obliquity of the pelvis on that side; but it will be noticed that the anterior superior spinous process of the ilium is not only lower—it

projects forwards and is more prominent, consequent on a tilting of the ilium forwards on the diseased side. I would not dwell on the attitude of the limb, which is usually straight, or very slightly bent at the groin and knee, perhaps also somewhat abducted and everted—altogether looking like a useless limb, the patient resting his whole weight on the other side. Ultimately, shortening takes place, and wasting, as destruction of the sacro-iliac articulation progresses.

Pelvic caries, with abscess, is distinguished from sacro-iliac disease by the different situation of the presenting swelling—in the iliac fossa, or at the tuberosity of the ischium; and there is no pelvic obliquity and prominence of the anterior superior spinous process. No shortening of the limb ensues.

Spinal caries can hardly be mistaken; for, being seated commonly in the dorsal region, the angular excurvation of the spine is removed from the sacro-iliac articulation.

Neuralgia affecting the hip is unattended with all those objective signs which relate to structural disease; and the severity of the pain, its paroxysmal character, and migration perhaps to some other part of the body is very unlike the tender or fixed painful swelling of sacro-iliac disease. The age and sex of the patient will probably aid the diagnosis; a young, hysterical female complaining of intense pain about the hip, diffused, superficial, or even cutaneous, and aggravated by the slightest handling, is not an affection likely to mislead the experienced Surgeon, who is intent upon discovering any evidence of structural disease. *Sciatica* also, as a painful affection, will be traced in the course of the great sciatic nerve, from the great sciatic notch downwards, external to, and lower down than, the pain of sacro-iliac disease; and which is unaccompanied with any swelling or other objective evidence of structural disease. Occurring, generally, at a more advanced period of life, and associated with a rheumatic tendency, our sciatic patient is soon recognized as a far more familiar friend than the very rare case of sacro-iliac disease we may happen to meet with.

Causes.—Acute inflammation of this articulation may result directly from *injury;* as in a case given by Louis, a sack of corn having fallen on the loins of a man who was stooping at the time. In Sir B. Brodie's case, the symptoms seemed referable to pregnancy, four years previously. From the histories of fifty-eight cases collected by Dr. C. T. Poore,* of St. Mary's Free Hospital, New York, it appears that in eleven the disease was the result of relaxation of the articulation consequent on pregnancy, or pyemic abscess. To rheumatism or gonorrhœa, one case each may be assigned. The disease has a scrofulous origin—according to Mr. Erichsen's experience; but he has never seen it in young children, only in young adults, from fourteen to thirty years old. No difference of liability can be traced to *sexual* predisposition, beyond the tendency arising from pregnancy; and in the above series of cases, there were thirty males to twenty-seven females. The *ages* ranged from four years, as the earliest period of life, to sixty-one, as the oldest. In one case only, both articulations were affected.

I have seen but one case of this disease, of which the history, by my notes, was briefly as follows:—F. H. H., aged eight, a weakly child from birth. The mother states that her four other children all

* "American Journal of Medical Sciences," January, 1878.

died of water on the brain. Five years ago, this child fell down a long flight of stairs. Four months subsequently, she limped from side to side, in walking, like the motion of a milk-girl in carrying her pails. Shortly afterwards, she had intermittent fever, which lasted about two months. She met with a second fall down a flight of ten steps, and afterwards the limping gait became more marked. Then, the right gluteal region was observed, by her mother, to be larger than on the left side. For two years she continued to walk on crutches. During this period, some slight curvature of the spine had taken place, in the loins, and a spine-support was put on by a Surgeon at the Orthopædic Hospital, in Oxford Street. A swelling presented near the vagina, on the right side, and that in the gluteal region remained. In April, 1866, she was admitted to the Royal Free Hospital. The symptoms were those of the disease in an advanced stage; abscess occupied the whole of the buttock, and pointed near the vagina, being therefore both extra-pelvic and intra-pelvic. Shortening of the limb, to a slight extent, had occurred, above the anterior superior spine of the ilium.

The *Course* of this disease, as already indicated, is most unfavourable; and thence the prognosis is equally so. Continuing for months or years, the *termination* is nearly always fatal. In Sir B. Brodie's case, however, although shortening had taken place, recovery ensued.

Treatment.—The same treatment, local and constitutional, as for disease of the hip-joint, represents the little that can be done in disease of the sacro-iliac articulation.

Removal of the diseased articular surfaces, by excision, is, of course, out of the question.

CHAPTER XXXVIII.

DEFORMITIES.

This large branch of Surgery forms the subject of several special Treatises. An abstract only—so far as the present discordant opinions respecting much of the pathology and treatment of Deformities will allow—can be given here: sufficient for the requirements of the general Student, and for reference, in accordance with the design of this work.

Deformities may be arranged in two general classes:—1, Acquired Deformities; 2, Congenital Deformities or Malformations.

Class 1 embraces those deformities pertaining, in origin or result, to:—

(1.) The Integuments—Burn-cicatrices.

(2.) Bones—Fracture-union deformity.
Rachitis, and Mollities Ossium.

(3.) Joints—Dislocations unreduced.
Diseases of joints with Anchylosis, and
Malposition of the Limb.

(4.) Musculo-Nervous System.
Spinal Curvature—Lateral.
Deformities of Face and Neck—Wry-neck—Squint.
Deformities of Arm and Hand—Contractions.
Deformities of Leg and Foot—Relaxations and Contractions—
Knock-knee—Bow-leg—Club-foot.

The first three of these sub-classes are considered in connection with other Injuries and Diseases; Deformities as Malformations also are thus associated;—*e.g.*, with Congenital Dislocations, and with the pathology of Organs and Regions—Hare-lip, extroversion of the Bladder, etc.

It remains only to here notice the affections included in the last sub-class (4); associating therewith any remaining Malformations of musculo-nervous origin or character, as that of congenital club-foot. Even in this sub-class, the following Deformity is more conveniently considered elsewhere.

Lateral Curvature of the Spine.—See Spine.

Deformities of Face and Neck.—*Wry-Neck* or *Torticollis.*—This deformity is a twist of the head and neck to one side, in the directions of action of the sterno-mastoid muscle; the head being drawn downwards, sideways, and rotated somewhat outwards. The ear of the affected side may be drawn down towards the clavicle. In proportion to the duration of this deformity, the face is turned askew, the features losing their symmetry. The sterno-mastoid muscle is firm, and stands out more prominently, though shortened, as compared with that on the opposite side. Other muscles apparently become involved, the anterior margin of the trapezius acquiring an outline which defines the posterior boundary of that named triangular space of the side of the neck. The cervical vertebræ slowly undergo lateral curvature with rotation.

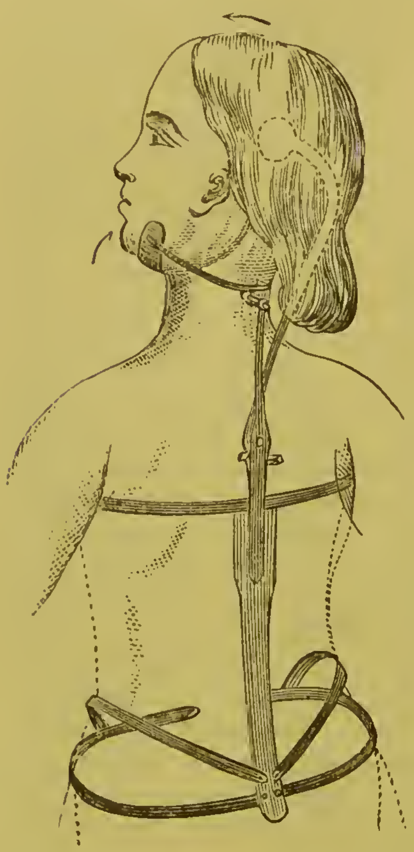
Causes.—*Congenital* wry-neck is the most common form of this affection. The side of the head, neck, and shoulder which present the deformity, appears to be considerably smaller than the parts on the opposite side, the shoulder and scapula unduly raised, and the features drawn down and unsymmetrial. The sterno-mastoid muscle is reduced to a narrow, shortened cord, hard and tense. Curvature of the cervical spine has taken place, laterally to the opposite side, and a compensating curve in the opposite direction lower down. *Spasmodic contraction* of the sterno-mastoid muscle of the affected side is a very rare cause of the deformity,—then known as *spasmodic* wry-neck. The special accessory nerve would seem to be the source of this muscular action, and hence its extension to the trapezius muscle. The spasm is remarkably jerking, painful, and constant, excepting during broken sleep, and it continues for many years; the sufferer ultimately sinking exhausted. This kind of wry-neck usually commences about the age of thirty, and in females not apparently hysterical, but whose families have an hereditary tendency to other cerebro-spinal affections. Sometimes, however, it is a symptom of hysteria. *Paralysis* of one sterno-mastoid is a rare cause of *paralytic* wry-neck. The head is drawn to the opposite side by the healthy muscle, not being counteracted by its antagonist. *Disease of the cervical vertebræ*, of scrofulous or rheumatic character, occasionally gives rise to the deformity. The *exciting* cause would appear to be, not unfrequently, exposure to cold, or some occasion of local irritation or inflammation of the cervical glands, resulting in stiffness of the neck. Burns of the neck, followed by contraction of the cicatrix, occasion remarkable distortions resembling wry-neck; but not depending on any affection of the muscles, they are thus distinguished from wry-neck thence arising.

Treatment.—Tenotomy, or the subcutaneous division of tendons and

muscles, represents a principle of treatment, applicable to a large class of conditions, for the cure or correction of deformities depending on muscular contractions. Thilenius, of Frankfort, divided the tendo-Achillis about 1789, followed by Sartorious in 1806, and Michaelis in 1809; but Delpech (1816) originated subcutaneous tenotomy as a method of treatment, by laying down the rules * essential to the performance of this operation, and Stromeyer brought the operation into practice in 1831; followed by Little and other Surgeons, who have established its remedial efficacy in various branches of surgical practice—constituting Orthopædic Surgery.

Division of the sterno-mastoid muscle, subcutaneously.—This procedure affords more or less complete relief of tension, when wry-neck deformity depends on contraction of the sterno-mastoid muscle. In congenital wry-neck tenotomy is most successful; in spasmodic wry-neck less so; while in the paralytic form, and that arising from disease of the cervical vertebræ, this operation will be unnecessary or useless. The muscle should be divided close above the clavicle, the situation of least risk to subjacent parts. By introducing a narrow-bladed tenotome just above the sternum, the sternal attachment of the muscle is divided; and then the clavicular attachment, by repuncturing the integument in that situation. This precaution is safer than division of the muscle by one incision; as the two portions are not on the same plane, and passage of the knife to a sufficient depth for that purpose would be dangerous. Complete division is accompanied by a very sensible crack, and some alteration in the attitude of the head. Immediately after operation, Dr. Little found the difference in length between the affected and sound muscle reduced more than one-half.

Fig. 443.



The advantage gained by this operation must be followed up by mechanical means, to maintain and gradually complete the readjustment of the head in position; otherwise, the divided portions of muscle reunite, and the deformity returns. An apparatus represented by Mr. Bigg (Fig. 443) best answers this purpose, by counteracting any tendency of the head downwards, sideways, and outwards, and thereby restoring it to its vertical position, and the chin to the middle line. Dr. Little highly commends cautious manipulation daily, as well as the use of a retentive apparatus. This after-treatment must be continued for a period varying from one to three or six months, when permanent cures have been accomplished.

If an hysterical affection, wry-neck should be submitted to the

* "De l'Orthomorphie," tome ii. p. 330. 1828.

general treatment for hysteria, as noticed in connection with Deformities of the Arm and Hand.

Paralytic wry-neck may perhaps be rectified by electricity, and other measures for the restoration of nervo-muscular action. A steel-spring cravat, or other contrivance for supporting the head, is the only mechanical resource available.

Disease of the cervical vertebræ, as the cause of wry-neck, can be remedied only by the measures—medicinal, dietetic, and hygienic—appropriate for the particular constitutional condition; and by wearing a well-adjusted, supporting, and slowly rectifying apparatus.

Strabismus or Squint.—A want of parallelism in the axes of the eyes, whenever both are directed to an object at the same time. This habitual malposition of the eyes results from irregular action of the internal or external rectus muscle; the one producing *convergent* strabismus—the eye being directed towards the nose; the other, *divergent* strabismus—the eye being directed towards the temple. Either form of strabismus may be *single; double*, when both eyes converge or diverge. The latter direction is rare, and consequent on loss of sight in one eye, which has lasted for years.

Causes.—Strabismus may arise from a cause remote in some distant part of the body, of which the squint is symptomatic; or from various local conditions pertaining to the eye; but more frequently from the former class of causes. Thus, this affection arises from intestinal irritation or teething; or from disease of, or relating to, the brain, as hydrocephalus. It may be consequent on certain blood conditions, as measles or scarlatina, among the eruptive fevers. Inflammatory or other diseases of the eyeball, conjunctiva, or eyelids represent the class of local causes. Extreme shortness of sight, compelling the patient to converge both eyes in looking at near objects, may also induce strabismus; and it sometimes results from the influence of insensible imitation.

Treatment.—Removal of the cause, in any case, will probably restore the regular and equal action of the recti muscles. Hence, any source of irritation in the intestinal canal or elsewhere should be sought for, and removed, if practicable. Persistent causes render this principle of treatment impracticable, and strabismus must then be rectified as an effect, by division of the contracting muscle. This operation, first introduced in 1840, has since been modified. It now consists in *sub*-conjunctival division of the muscle affected; commonly the internal rectus. The details of this procedure are described in the chapter on Diseases of the Eye.

Deformities of Arm and Hand.—Contraction of the muscles of the upper extremity differs from those of the lower extremity, in so far as the individual muscles of their analogous parts perform functional movements, more delicate, varied, and complex. Various muscles may be affected, producing deformities which correspond to their respective functions. Thus, contraction of the biceps is accompanied with permanent flexion of the arm, or the extensors of the forearm, the flexors of the fingers, or those of the wrist, or the pronators, may be severally engaged. As affecting the fingers, muscular contractions produce forms of *club-hand.* Hysterical contractions are met with, and either of a spasmodic or tonic character; but these muscular affections are distinguished by an absence of any evidence of local

disease, as thickening or adhesion, or of any traumatic origin, as a blow or strain. They arise spontaneously, as it were, and, after a while, as capriciously cease; and are associated with other manifestations of hysteric constitutional disease. Some such cases are graphically told by Mr. Skey in his Lectures on this subject.

The *causes* of these contractions, and resulting deformities, are either spasmodic or paralytic conditions; and as depending on some injury or disease affecting the nervous system peripherally or centrally. If an hysterical affection, the search for any locally causative condition will often be in vain. Its evil origin lies deeper, as a constitutional malady, the offspring perhaps of an hereditary predisposition, or of a vicious social education. The prominent elements of hysteria—general debility and muscular irritability—are, however, not unfrequently associated with some disordered function of the uterus, or of the digestive organs; in males especially, hysteria being manifested as a rare expression of the bilious or hypochondriacal temperament.

Treatment must have reference, primarily, to removal of the cause of contraction or paralysis, if possible. Hysterical contractions—rarely admitting of any such radically curative treatment—may perhaps be overcome by remedial measures of a medicinal and hygienic character. A course of tonics and anti-spasmodics—iron and quinine, in their various preparations; the sulphate of copper or zinc; nitrate of silver; the preparations of valerian, assafœtida, or ether, sulphuric ether in particular—may prove effectual in different cases; but any such treatment must be accompanied and reinforced by the judicious exercise of body and mind, aided by the salutary influence of pure air and sea-bathing, when the latter can be borne. The uterine and digestive functions must be regulated by appropriate treatment. Topical applications, of a sedative character, to allay pain and spasm, as by opiate ointment or the hypodermic injection of morphia, the ointments of belladonna or aconite, seldom afford more than temporary relief. The inhalation of chloroform has the same effect; but its relaxative influence is of value chiefly in the examination of the part affected, to determine the nature of the contraction.

The state of contraction, as an effect, may be overcome mechanically; by manipulations, or by division of the contracted muscle or muscles, or their tendons—the operation of tenotomy; followed, in either case, by the use of retentive appliances. The choice of these two procedures will be determined by the kind and degree of motion to be regained in the part, and by the practicability of aiding recovery by means of any apparatus. Thus, according to Dr. Little's experience, the biceps at the bend of the elbow, the tendons of the flexor carpi radialis and ulnaris close to the wrist, and the pronator radii teres at its muscular portion, have been severally divided in different cases; but the resulting benefit of these procedures has been proportionate to the after-manipulations, passive exercises, and painstaking education of the enfeebled non-contracted extensors. The fingers derive little benefit from any limited degree of the simple movements of flexion and extension, nor can they be assisted by any known form of mechanism.

Contraction of the Fingers, as depending on the *palmar fascia*, should be distinguished from contraction of nervo-muscular origin. The pathological condition was discovered, on dissection, by Dupuytren and Goyrand.

It is said to result not unfrequently from habitual pressure on the palm of the hand, as in bearing on a knob-headed walking-stick, or using an instrument which has this effect, in the exercise of various trades; but this mode of origin is doubtful. But, without any apparent exciting cause, a rheumatic or gouty diathesis—and, so far, habitual intemperance—may give rise to chronic thickening or hypertrophy of the palmar fascia, in the form of projecting ridges extending towards the palm of the contracted fingers. (Fig. 444.) The little finger and the ring-finger are commonly affected first, and most severely; the middle and fore-fingers less in frequency and degree, while the thumb is rarely involved. The articulations are usually free. It is a painless affection, and progresses very slowly; thickening and contraction proceeding until the fingers may become tightly clenched, and even the nail pressed into the palm. Both hands sometimes undergo contraction, and symmetrically; or the disease may be associated with a similar hypertrophied condition of the plantar fascia in the soles of the feet.

Fig. 444.

The *treatment* is, in principle, the same; manipulations, with mechanical extension, or subcutaneous division of any tense *fascial* prolongations binding down the fingers. Sometimes, owing to firm adhesion of the skin to these bands, it has been the practice of some Surgeons to make a long incision and dissect back the skin on either side; the bands must then be divided or dissected off the tendons, leaving their sheaths intact. After either operation, the fingers are to be straightened and retained in position on a splint. In the case of a clergyman, aged seventy-nine, the *tendons* were involved, apparently as the result of chronic rheumatic inflammation, and presented an appearance nearly like that depicted in the figure. Both hands were similarly affected. Being a man of uncommonly robust constitution, I performed tenotomy on the right hand, and then applied a palmar splint, padded so as to separate the divided ends of tendon by about half an inch, under a small lint compress; in the course of a week, gradual extension was practised, and the fingers were brought down straight, whereby the free use of the hand became quite restored. Some tendency to the recurrence of contraction was checked by wearing for a time finger stalls, with elastic extending braces, attached to a wrist-band,—a little contrivance made by Mr. Bigg. As a rule, tendons in dense sheaths are unfitted for tenotomy; suppuration taking place up the sheath, or no union of the ends of tendon.

Fig. 445.

Congenital Deformities of the Fingers may be met with. Erichsen saw a case in which the fingers appeared as if they had undergone complete or partial amputation *in utero*. Some were marked by deep transverse sulci, others shortened and terminating in rounded nodules, with a narrow pedicle attaching them to the proximal phalanx. *Supplementary* fingers, or a thumb, are found in some cases. (Fig. 445.)

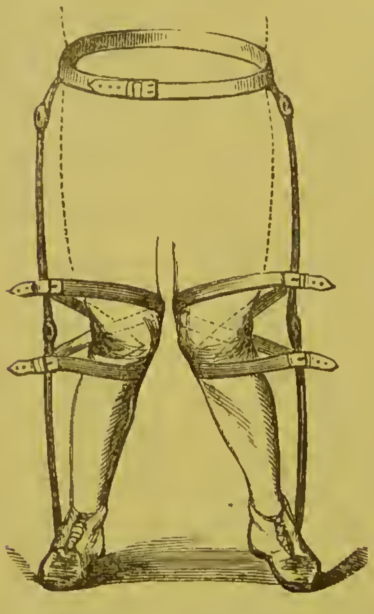
Deformities of Leg.—(1.) *Knock-knee* or *In-knee—Genu Valgum.*—This deformity is an inward yielding of the knee-joint, the result of weakness of the ligaments and muscles which support the joint in that direction. It happens not unfrequently, and usually both knees are affected; giving the person a singularly ungraceful attitude when standing, and in walking the knees knock and roll over each other with a shuffling gait.

The *causes* of knock-knee are apparently *mechanical;* some occasion of undue strain on the knee. It mostly arises from trying to make a child walk too early, or it may occur in tall, rapidly growing lads from the age of twelve to eighteen; in either case the knees yielding under the weight of the body. Habitual over-walking exercise or fatigue in standing has the same result. Hence certain occupations are causative; and any habit of resting on one leg, or defect in the opposite limb, whereby an increased strain is thrown upon the sound limb, may induce this deformity. But a rachitic tendency, or other *constitutional* condition of impaired nutrition, can often be traced as the predisposing cause.

Treatment.—Removal of the cause in operation will sometimes prove sufficient. Thus, if the attempt to make a child walk at too early a period be discontinued, an incipient knock-knee may disappear.

Mechanical support is the only sure means of preventing further deformity, and of restoring the limb to a proper shape, by allowing the ligamentous structures to gain sufficient strength. The patient must be placed in "irons." An iron stem, on the outside of the limb, extending from the trochanter to the outer ankle, is fixed by a pelvic band above, and into the boot below. A hinge in this rod at the knee allows of motion; while, by means of a leathern pad furnished with straps, applied on the inner side, the joint is secured to the stem above and below the hinge, and drawn outwards by tightening the straps. (Fig. 446.) The knee must thus be fixed during a period varying from three to six months; then freedom of motion may be allowed for a part of each day during a similar period; and, lastly, perfect freedom a few months before the support is discontinued. The total average duration of treatment, in advanced childhood and bad cases, will probably extend to two years.

Fig. 446.



Division of the external lateral ligaments, or of the *biceps tendon*, has been practised in obstinate cases; but this, or any cutting operation, is not now considered necessary. Constitutional treatment for the improvement of nutrition will aid the mechanical cure.

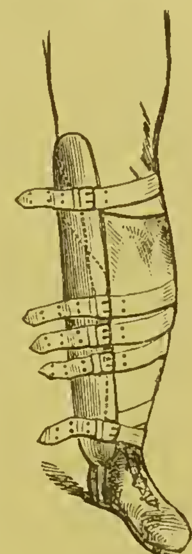
(2.) *Bowed*, or *Bandied Legs—Genu Varum*—present the opposite state of deformity of the Knees. (Fig. 447.) This deformity arises from relaxation of the external lateral ligament, and not, probably, from any contraction of the biceps femoris muscle. The *treatment* will

consist in a form of apparatus to correct eversion of the knee. The simplest is an inner lateral splint (Fig. 448), as a base opposed to the convexity of the curve.

In either kind of deformity, Genu Valgum or Varum, the condyles and articular surfaces of the femur and tibia at length undergo changes of form, which are incurable. Hence the importance of early treatment.

FIG. 447.

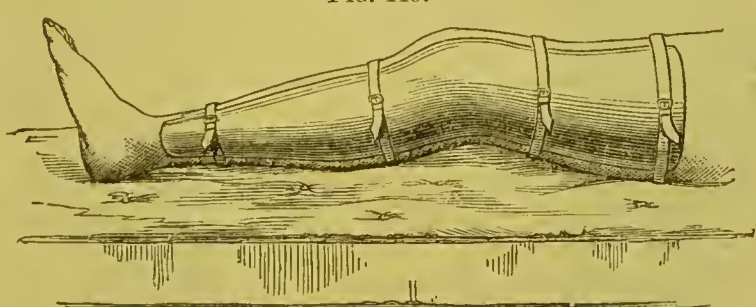
FIG. 448.



(3.) *Contraction of Knee-joint.*—Unconnected with disease of the joint, resulting in anchylosis with malposition, *simple* contraction of the knee is liable to take place. The deformity may be either *flexion* of the leg on the thigh, at an angle of various degrees, or, combined with this state, some distortion *laterally* inwards, with rotation of the tibia outwards. Displacement *backwards* of the head of the tibia, the end of the femur and patella projecting forwards apparently, is associated with rather an extended position of the leg, and laxity of the joint.

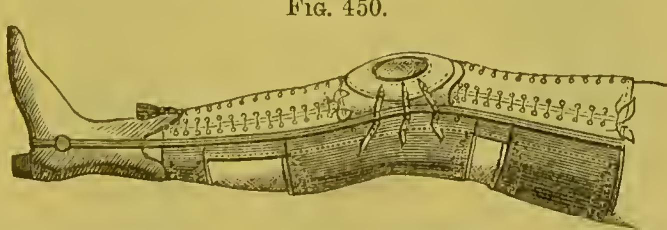
The *cause* of these deformities—apart from joint-disease—seems to be some affection of the ham-string muscles, which induces their contraction, and shortening ultimately. This may be a purely *hysterical* manifestation, and accompanied with other symptoms of the same constitutional disease.

FIG. 449.



Treatment must have reference to the apparent cause of contraction. The more fugitive state of hysterical contraction can be overcome under the relaxing influence of choloroform; the limb is then at once brought down to a straight position, and retained by two lateral splints.

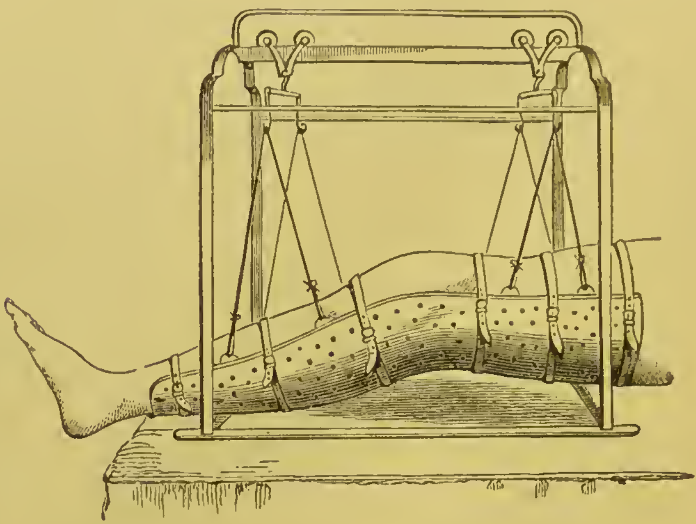
FIG. 450.



(Fig. 449.) Or, reduction is gradually accomplished by a regulated extending apparatus. (Figs. 450, 451.) Division of the ham-string

tendons may be necessary, followed by extension. I have done this, in some cases, with entirely satisfactory results. The biceps and semi-tendinosus always require division; the semi-membranosus, seldom.

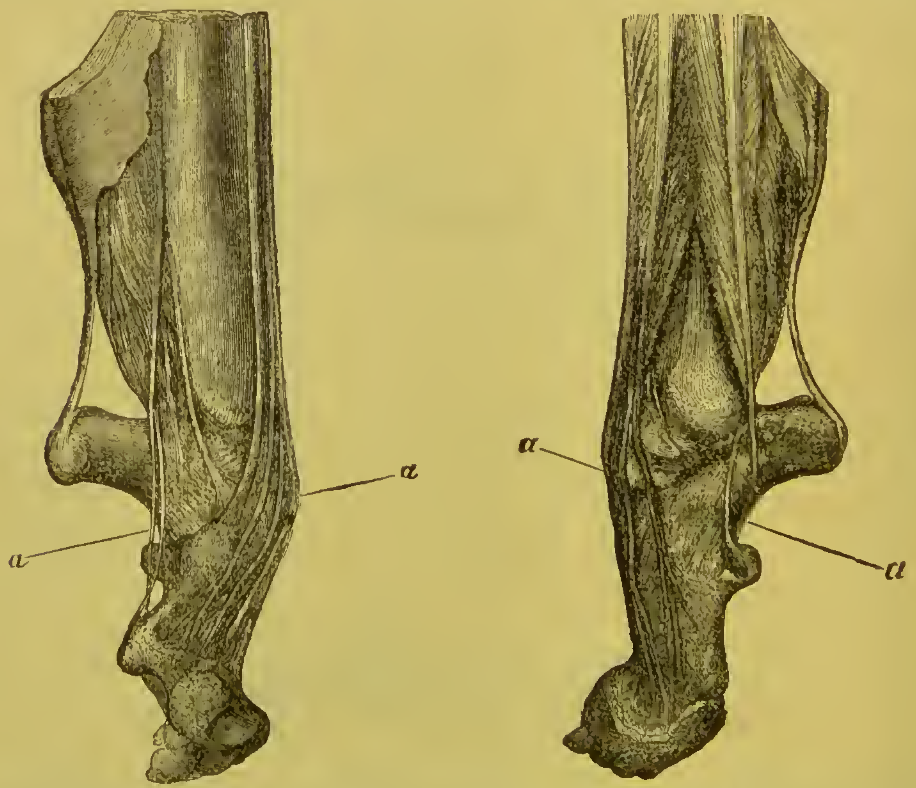
Fig. 451.



This renders the operation more superficial and simple than it would otherwise be.

Talipes or Club-foot.—Four forms of club-foot are recognized: *talipes equinus*, or elevation of the heel; *talipes varus*, or inversion of the

Fig. 452.*



* Talipes equinus; the deformity depending chiefly upon flexion of the foot upon itself from the transverse tarsal joint, in line *a a*. (After W. Adams.)

foot; *talipes valgus*, or eversion of the foot; and *talipes calcaneus*, or depression of the heel with elevation of the anterior part of the foot. *Varieties* of club-foot consist of combinations of two of these forms, the principal of which are—equino-varus, equino-valgus, calcaneo-varus, and calcaneo-valgus.

(1.) *Talipes Equinus.—Structural Conditions, and Signs.*—Certain bones of the tarsus—the astragalus, scaphoid bone, and calcaneum—have undergone alterations from their normal condition. Diminished in size somewhat, the astragalus, in particular, is reduced, its natural articular surfaces for the tibia and fibula are partially deprived of cartilage, and new articular relations have formed posteriorly, more or less in that direction according to the degree of the talipes. The calcaneum may even contribute to this new articulation. The head of the astragalus, dimished in size, has an unusually small articular facet in its connection with the scaphoid bone. The latter bone, also reduced in size but unaltered in shape, is drawn downwards; thus presenting the head of the astragalus prominently on the dorsum of the foot, while a considerable portion of its upper surface has slid from under the tibia. (Fig. 452.) The calcaneum, small, and perhaps articulating with the tibia, has a more limited connection with the cuboid bone; and as the latter bone, with the scaphoid, is drawn downwards, the anterior and upper portion of the calcaneum also projects forwards on the dorsum of the foot. The other bones of the foot, somewhat smaller than natural, retain their normal characters; the remaining tarsal and the metatarsal bones conform to the general curvature—an increased convexity forwards, an increased concavity backwards; but the toes are usually extended horizontally, and from constantly bearing the weight of the body, the breadth of the fore portion of the foot becomes increased.

Fig. 453.*

Fig. 454.†

Thus, then, the heel drawn up, in this form of talipes, brings the tarsus to nearly a vertical line under the tibia, whereby the weight is transmitted to the toes, on which the patient rests in standing or walking. (Fig. 453.) But the fore part of the foot may be completely retroverted, so that the sole forms an acute angle with the projecting heel, and the weight is borne on the dorsum (Fig. 454); the cuticle there acquiring a thickened, horny character, as if it were on the sole of the foot. This callosity is liable to ulcerate or slough. The ligaments are relaxed and shortened, corresponding to the altered relations

* Talipes equinus, *without paralysis* of the extensor muscles. Extension of the toes upwards, from their metatarsal articulations, on which the foot rests. (From W. Adams.)

† Talipes equinus, *with* paralysis of the extensor muscles. Backward flexion of the toes, from their metatarsal articulations, on which the foot rests. (From W. Adams.)

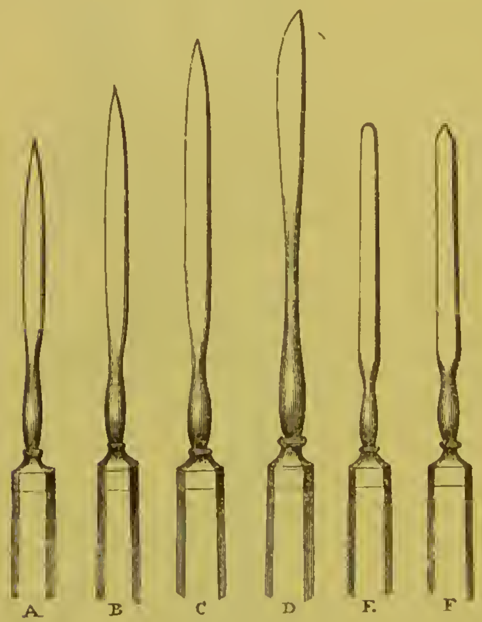
of the bones; which facilitates the progress of the deformity, and impedes restoration of the foot to its natural position. The muscles, however, are the active agents in the production of talipes, one muscle or set of muscles overbalancing another and antagonistic muscle or muscles. In talipes equinus, the *gastrocnemius* muscle is contracted. Fatty and fibrous degeneration of the muscular tissue ensues, as the result of old-standing talipes, especially when of paralytic origin.

This form of talipes is usually single; but both feet are sometimes clubbed.

Causes.—The disturbed equilibrium of muscular action, in the production of club-foot, may be spasmodic, when referable to the contracted muscle; or be due to paralysis of the opponent muscle. Thus, in talipes equinus, spasmodic contraction of the gastrocnemius may give rise to this deformity (Fig. 455); or a paralytic state of the tibialis anticus, or of it and one or more of the other extensors of the foot, be the cause in question. Either muscular affection, spasmodic or paralytic, proceeds from some disease of the nervous centres, commonly of an inflammatory character, which results in effusion or softening; or, when congenital, some defect of development in the nervous centres may be the causative condition. But spasmodic contraction is frequently a manifestation of reflex nervous action through the peripheral nervous system, from various sources of irritation; as teething, or intestinal worms. On the other hand, local irritation is more often the cause of contraction; generally local inflammation, of a rheumatic, scrofulous, or erysipelatous character, or as a consequence of injury. Thus, the muscles of the calf of the leg may become affected.

FIG. 455.*

FIG. 456.



Talipes equinus may be acquired or congenital; the latter very rarely, Tamplin, Lonsdale, and other authorities never having seen such a case.

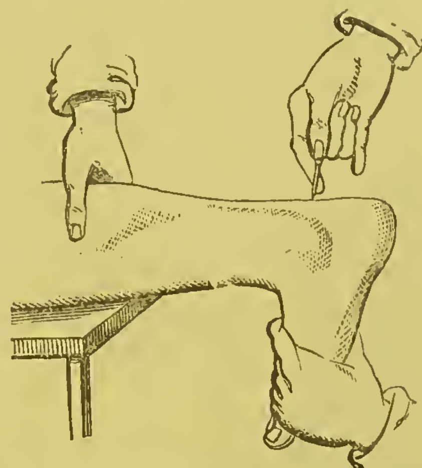
Treatment.—Tenotomy is the only mode of cure, otherwise than when the deformity is slight and pliable. Subcutaneous division of the tendo-Achillis allows the heel to be brought down; but this must be accomplished through gradual extension, the foot being retained in position by a properly constructed extending apparatus.

The operation is simple. The patient having been laid prone, the Surgeon grasps the foot and extends it forcibly, thus making the tendon tense and prominent; a tenotomy knife (Fig. 456) is intro-

* Talipes equinus, with *spasmodic* contraction; the toes extended from their metatarsal articulations, and flexed upon themselves, claw-like. (From W. Adams.)

duced, at either side of the tendon, about an inch above its insertion into the calcaneum; passing beneath the tendon to its opposite side, the knife is withdrawn through the tendon slowly, or division may be effected by pressure with the edge of the blade, the tendinous fibres yielding with a creaking resistance, while, at the same time, the fore-finger of the left hand is applied over the tendon gently, just to give warning of the approach of the blade to the surface. The foot at once comes into position, or is readily brought down by extension with the hand, as the tendon is divided. (Fig. 457.) Scarcely more than a drop or two of blood escapes externally, and the puncture is closed by a small pad of lint.

Fig. 457.



The apparatus for extension is known by the name of Scarpa's shoe, or its modification by Liston. Liston's shoe was provided with two curved levers. (Fig. 458.) The form of apparatus, or shoe, generally used for talipes equinus, is here represented. (Fig. 459.) It consists of a steel splint on the outer side of

Fig. 458.

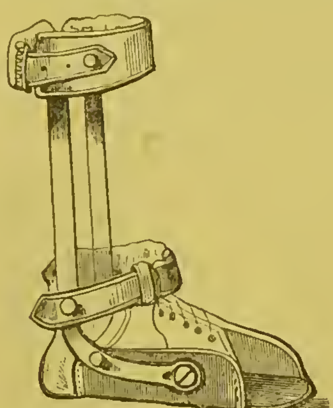
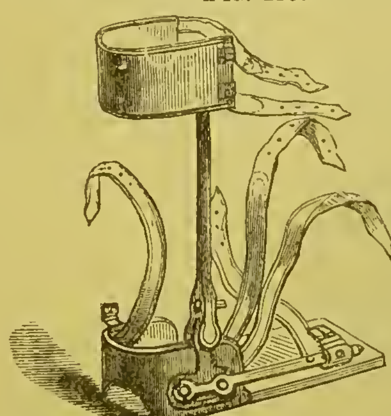


Fig. 459.



the leg, with a foot support; both of which are secured by padded belts around the leg and foot. At the connection of the splint and foot-board, a joint with a cog-wheel, worked by a key, regulates the extension.

Stromeyer postponed extension until the puncture-wound had healed, and then applied it gradually. Both rules are still observed by Little and other authorities. A pliant splint of pasteboard or metal is applied, after the operation, to retain the foot in its former position. On the fourth day, extension may be commenced, and it should be continued gradually until completed in about a month. Union of the tendon thus becomes more perfect, and without entailing any risk of recurring deformity; the new portion of tendon being elongated to a proper length, without weakening it, while the alterations, articular and ligamentous, are slowly overcome. Walking may be resumed as soon as the movements of the foot are regained, without any tendency to relapse—in, say, six weeks or two months; the period of rest required being, of course, much lessened by wearing the precautionary apparatus

above described. Ultimately, friction, passive motion, baths, and galvanism prove serviceable in completing the restoration of function.

Slight talipes equinus will perhaps yield to mechanical extension, without tenotomy.

Relapse sometimes takes place after an apparent cure. This may be remedied by the judicious reapplication of extending apparatus; or a repetition of tenotomy may be necessary, followed by extension.

Paralytic talipes equinus cannot be radically cured by tenotomy, nor by extension, which releases or overcomes the contracted muscles, but does not restore the action of the paralyzed antagonistic muscles. This condition depending sometimes on disease or congenital defect of the nervous centres, may be so far incurable. But, if the paralysis be incomplete, some restoration of power in the muscles affected may be gradually gained by the voluntary exercise of such muscles—the *gymnastic* or "movement" method of treatment—as of the extensor muscles of the foot, in talipes equinus. The influence of *electricity*, as a means of exciting contractile power, offers a most valuable resource in these local paralytic affections. This method of treatment must, however, be judiciously conducted; and is considered more particularly in works on Medical Electricity. *Mechanical* contrivances may also be used with advantage. The "artificial muscle," invented by Mr. Barwell, consists of an india-rubber band, adjusted so as to supply continued traction in the direction of the muscles affected.

Similar principles and modes of treatment are applicable in other conditions of paralytic club-foot.

(2.) *Talipes Varus.*—This is the ordinary form of congenital club-foot; but it also occurs, in a less severe form, as a non-congenital affection, from infantile paralysis.

FIG. 460.*

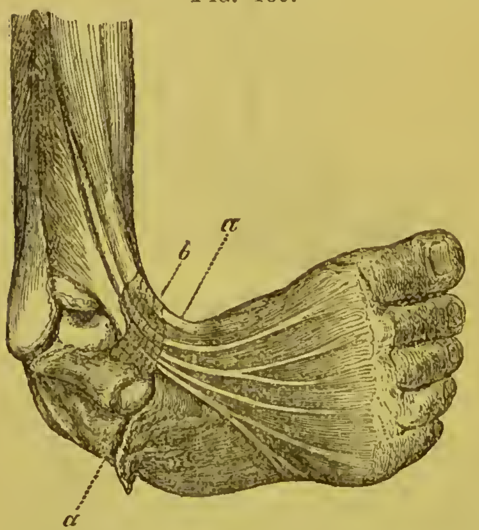


FIG. 461.†

* Congenital talipes varus, in a child aged six months. Anterior view. Ankle-joint, and transverse tarsal joint, *a a*, are laid open, showing altered relations of astragalus and scaphoid bone; *b*, point for division of the anterior tibial tendon. (From W. Adams.)

† Posterior view of the same foot, showing relative position of tendons.—*a*, Point for division of the posterior tibial tendon, just above the inner malleolus; *b*, anterior tibial tendon, crossing the inner malleolus, and inclining backwards. The elevation of the os calcis, and position of its tuberosity behind the fibula, and inclination of the tendo-Achillis, towards the fibula side of the leg, are also shown. (From W. Adams.)

The *structural condition* is similar, with regard to the alterations of the bones. But the muscles contracted are principally the gastrocnemius, *with* also the tibialis anticus and posticus. (Figs. 460, 461.) The articular alterations, and the accompanying signs, are more like those of equinus, in proportion to the extension and curvature of the foot, which commonly occurs; but the *foot* is turned *inwards*, or *inverted* and *adducted;* and these are tho characteristic distinctions. The patient walks on the outer side of the foot (Fig. 462); or with extreme inversion, the weight is borne on the dorsum.

The *causes* of this deformity would appear to be those of talipes equinus; but the varus form of talipes has been attributed to pressure

Fig. 462.*

(1.)

(2.)

of the walls of the uterus. It is certainly most frequently congenital; almost as exclusively so as the equinus form is acquired talipes. Both feet, therefore, are usually affected. When only one foot is the subject of deformity, the right is twice as often affected as the left. A certain liability due to *sex* is shown by the greater frequency of congenital talipes in male than in female children, the proportion being three to one. Hereditary influence is often evinced, and by descent from either parent. Thus, on the father's side, Dr. Little has traced congenital club-foot through four generations; the male infant, the father, the grandfather, and the great-grandfather. The tendency to hereditary propagation on the paternal side is, perhaps, the strongest argument against the influence of uterine pressure in the production of congenital talipes varus.

Treatment.—In slight cases, remedial measures may consist in gradual mechanical extension, aided by passive motion-manipulations. A tin splint should be applied, adapted to the calf of the leg, and provided with a foot-piece jointed at the ankle, the whole being properly padded; and this should be so adjusted and bandaged as not to forcibly coerce the foot, in undoing the deformity. This method of treatment having failed, or when the varus is more extreme, operative interference must be resorted to, subject to Dr. Little's test—that when the foot is held in the normal position, it springs vigorously back into the abnormal as soon as it is left to itself. The operation should not be delayed longer after birth than a month, and it has been performed within the first twenty-four hours with rapid and permanent success.

Tenotomy for talipes varus consists in subcutaneous division of the

* Congenital talipes varus, in adult.—(1) Anterior view; (2) posterior view. (After W. Adams.)

tendons of all the contracted muscles; both the tibial tendons, and the tendo-Achillis. This procedure may be accomplished in one operation. But, in extreme cases, the compound deformity must be overcome by a double operation; first, section of the tibial tendons, and of any prominent band of plantar fascia, thus to rectify inversion, coupled with the application of mechanical eversion; then, secondly, after the lapse of a month in the case of infants, or from two to four months for adults, the tendo-Achillis is divided. The advantage gained by this two-fold procedure—first recommended by Dr. Little—is that, in the interval of the two tenotomies, the calcaneum affords a resting-point, fixed by the Achilles tendon, from which to stretch out and unfold the contracted and involuted sole of the foot. Otherwise, incomplete recovery often results; in fact, a secondary talipes calcaneus may be produced, which deformity it will be difficult or perhaps impossible to overcome.

The operation—according to Dr. Little's precise directions—is thus performed; taking the tendons conveniently in order, as posterior tibial, anterior tibial, tendo-Achillis. The child being laid upon its back, with the limb rotated well outwards, an assistant holds the knee securely, and the Surgeon, seating himself in front, takes the heel of the foot in his left hand, and abducting the foot with his right hand, puts the posterior tibial tendon on the stretch, and with sufficient prominence to feel it under the left thumb; or failing in this way to find the tendon, in a fat subject, the guide will be from the inner margin of the tibia, a line drawn exactly midway between the anterior and posterior borders of the leg, on its inner aspect. Then, entering a sharp-pointed tenotomy knife about a finger's breadth above the lower end of the inner malleolus, and close to the margin of the tibia, it is passed perpendicularly to a depth of a quarter to half an inch, and an opening made in the fascia; a probe-pointed tenotome is then introduced between the tibia and the tendon, and this is divided by a slight lever-like cutting motion with the knife, while the assistant firmly abducts and depresses the inner border of the foot. A sudden jerk more or less plainly announces the division of the tendon. The puncture is closed with a dossil of lint. This operation may be completed with one knife instead of two; but in fat children it will be safer to substitute the blunt-pointed knife in dividing the tendon, lest the posterior tibial artery be wounded, as in talipes varus the tendon lies unusually close to the vessel. This accident, however, has happened in the most experienced hands. The arterial hæmorrhage can be readily arrested by a compress and bandage, which should be continued for three weeks, before beginning extension. Velpeau divided the tendon at its insertion into the scaphoid bone, observing to insert the knife to meet the tendon about an inch below and in front of the inner malleolus, on the adult foot. In infants or children, this method would be impracticable. Next in order, the anterior tibial tendon is divided, the assistant abducting the foot, while a sharp-pointed tenotomy knife is entered flatwise, near the outer edge of the prominent tendon, opposite the inner malleolus; passing the blade beneath the tendon, the edge is turned forward and elevated, as the skin is guarded by feeling with the finger of the left hand, until the tendon yields with a snap. A dossil of lint is placed over this puncture also.

Lastly, the tendo-Achillis is divided in the manner already described. But here again the posterior tibial artery is in danger; the tendon, in some cases, being drawn inwards by the adducted state of the foot.

The operations of tenotomy thus stated in detail, can be carried out in a few seconds each, and are bloodless.

After the operation for varus, the usual rule should be observed with regard to the after-treatment of club-foot; that the foot be left in its former position until the punctures have healed—about four days—during which time a moulded splint of paste-board or pliant metal may be applied, just to secure this position and rest the foot. Then mechanical extension should be continued gradually for a period of two weeks to a month, or even to three months, having regard to the degree of deformity and the age of the patient. The shoe most generally used, a modification of Scarpa's, is here shown. (Fig. 463.) Aveling's talivert is a useful contrivance, combining the three desiderata—abduction, flexion, and eversion. Dr. Langaard's well-known instrument for talipes varus is also deserving of notice. (Fig. 464.)

Fig. 463.

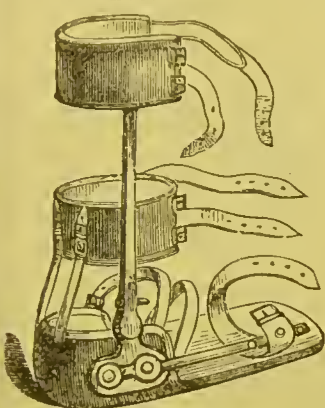
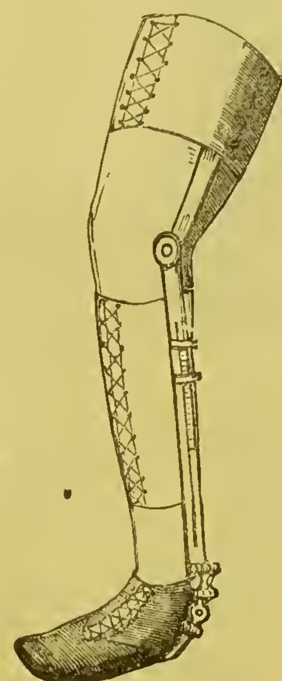


Fig. 464.



Relapse sometimes takes place, or the conversion of the deformity into the opposite state occurs, talipes valgus succeeding. In one such case, I found it necessary to resort to the operation for that deformity.

(3.) *Talipes Valgus*—or *in-ankle*—presents the opposite arrangement of parts to that of talipes varus, and the peronei muscles are chiefly contracted, with, perhaps, the extensor longus digitorum. The foot is turned *outwards*, or *everted*, and *abducted*, possibly also extended upwards, the patient standing or walking on the inner ankle. (Fig. 465.) Thence also the knee inclines inwards, combining knock-knee with this form of talipes.

Fig. 465.*

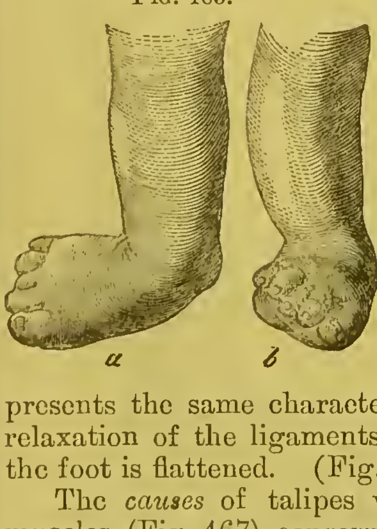
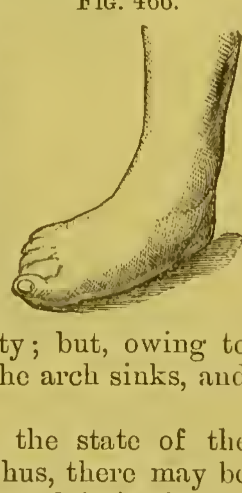


Fig. 466.



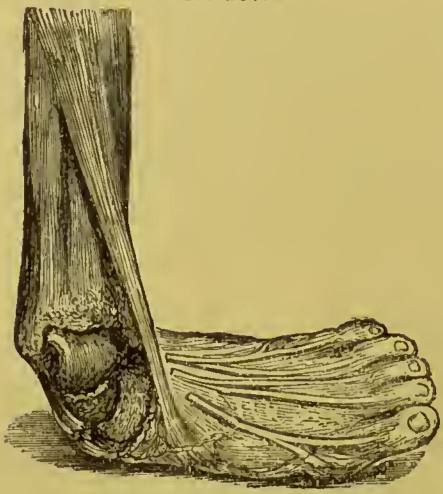
Flat or Splay-foot presents the same characters as the above deformity; but, owing to relaxation of the ligaments in the sole of the foot, the arch sinks, and the foot is flattened. (Fig. 466.)

The *causes* of talipes valgus have reference to the state of the muscles (Fig. 467) concerned in its production. Thus, there may be a spasmodic contraction of the peronei, as from dental irritation in

* Talipes valgus—congenital.—*a*, Showing depression of the inner, and elevation of the outer margin of the foot; *b*, showing obliquity of the foot. (From W. Adams.)

childhood, or a paralytic condition of their opponent tibial muscles, as a sequel of infantile paralysis. Occasionally, valgus is the result of injury, as from the cicatricial contraction of a burn; and sometimes it is consequent on disease of the ankle-joint. This deformity may be congenital, but far more often it is acquired.

Fig. 467.*



Flat-foot is said to arise, in young persons, from long-continued standing or walking. I have seen it commence in girls who have suddenly become stout and heavy, about the age of puberty; the arch of the foot and inner ankle then giving way.

The *treatment* of talipes valgus must be conducted on the principles already laid down in the other forms of club-foot. Tenotomy will generally be necessary; and the tendons to be divided are those of the peronei muscles, about an inch above the outer malleolus; and possibly also the extensor communis digitorum, in front of the ankle-joint. The foot is afterwards placed in a Scarpa's shoe. The best form of instrument is that devised by Dr. Langaard, of Hamburg. (Fig. 468.) It is provided with a tangential ankle-screw.

Slight deformity of this kind can sometimes be corrected by extension, under the influence of chloroform; and subsequently wearing the shoe.

Flat-foot is amenable to the same plan of treatment, with the addition of a convex sole to restore and support the arch of the foot.

Fig. 468.

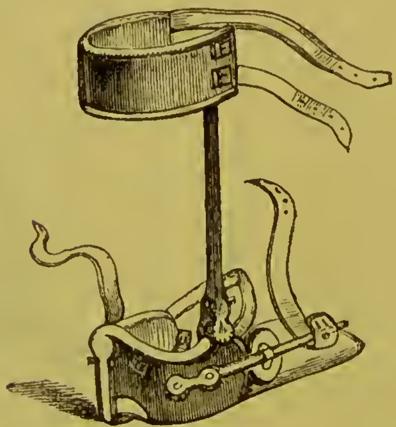


Fig. 469.†

(4.) *Talipes Calcaneus.*—Marked depression of the heel, and a corresponding extension upwards of the foot, characterize this deformity. (Fig. 469.) No structural alterations have taken place,

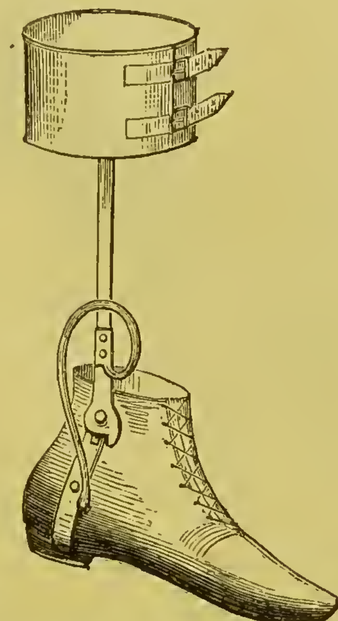
* Talipes valgus—congenital. Showing the elevation of the os calcis; oblique position of the astragalus; and displacement of the scaphoid bone by transverse rotation. (From W. Adams.)

† Talipes calcaneus—non-congenital, in the adult. (After W. Adams.)

but the deformity is simply symptomatic of muscular contraction; the muscles engaged being the four whose tendons pass between the two malleoli, anteriorly—the tibialis anticus, extensor pollicis, extensor longus digitorum, and peroneus tertius, a part of the last-named muscle. The lateral ligaments, in their posterior portions, are much elongated. This form of talipes is very rare, and was first described by Dr. Little, in the case of a child, four and a half years of age. It

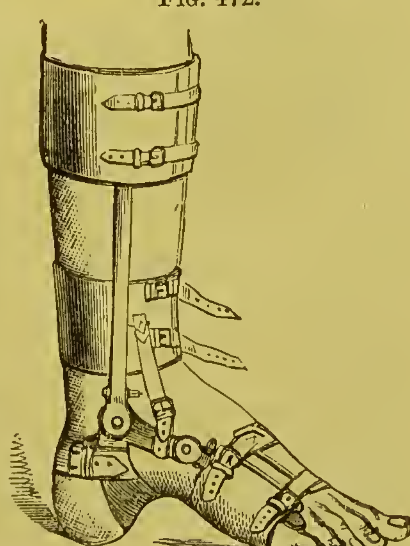
FIG. 470.*

FIG. 471.



is congenital. Or, the heel may drop, from paralysis of the muscles of the calf of the leg —the gastrocnemius and soleus; and the plantar arch become contracted, partly by shortening of the plantar fascia, with contraction of the flexor muscles of the foot, which thus completes the arching of the sole downwards. (Fig. 470.) This form of calcaneus is acquired, and especially when the plantar fascia is involved in producing the deformity.

FIG. 472.



The *treatment* is much facilitated by the absence of any structural impediments. Reduction can be easily accomplished by flexion alone, with support of the heel, or aided by tenotomy; and the foot is readily retained in position. The best form of instrument, or shoe, for treatment mechanically, in order to restore the normal position and actions of the foot, is that shown in the annexed figure. (Fig. 471.) Bigg's apparatus is well adapted for cases of the second form, and of great severity. (Fig. 472.)

Varieties of Club-foot.—Combinations of the typical forms of club-foot are met with. They have already been adverted to; but, to simplify the descriptions given, it was desirable not to introduce these varieties in connection with their respective types.

* Talipes calcaneus—non-congenital, in the adult. (After W. Adams.)

Equino-varus, *equino-valgus*, *calcaneo-varus*, and *calcaneo-valgus* are modifications of the typical forms of club-foot. The particular muscles contracted will be suggested by each of these varieties of deformity. But the muscles engaged are declared by the tension and prominent

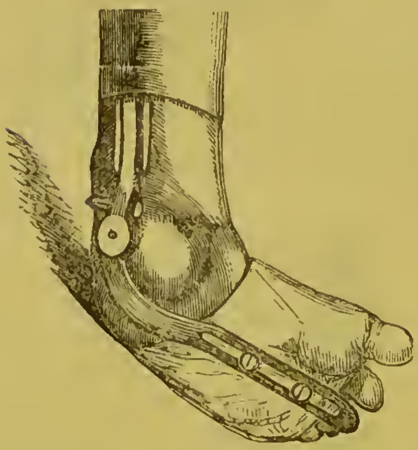
FIG. 473.*

FIG. 474.†

rigidity of their tendons, as at once discovered by manipulative examination of the foot, in the various attitudes it has assumed. (Figs. 473, 474.)

Practically, this knowledge guides the appropriate orthopædic treatment; the manipulative extensions, the operations of tenotomy, and the mechanical appliances. For *equino-varus*, to restore the foot to a normal position, Bigg's orthopede promises to be a valuable instrument. (Fig. 475.)

FIG. 475.



In all cases of talipes varus, or equino-varus—the latter class including many cases of relapsed varus, after failure of operative and mechanical treatment—the best practical rule is to divide the treatment into two, and in some cases three, stages.

In the *first stage* the object is to overcome all inversion of the foot, and thus to convert the more complex deformity into the simple form of talipes equinus. This may be accomplished in some cases by mechanical means alone, bandaging the foot for this purpose to a splint applied along the outer side of the leg and foot; in other cases, it is necessary to employ tenotomy, followed by the use of the outside splint, the anterior and posterior tibial tendons being divided. This stage will not occupy more than three or four weeks in infants, but may take two or three months in adults.

In the *second stage*, where talipes equinus alone remains, this may be cured by division of the tendo-Achillis, and the foot afterwards gradually brought into a natural position by the use of a Scarpa's shoe

* Talipes equino-varus, with *spasmodic* contraction of the muscles. (After W. Adams.)

† Talipes equino-varus, with *paralytic* condition of the muscles. (After W. Adams.)

in children over five years of age, and in adults; but in infants it is better to use the apparatus known as a varus-splint, consisting of a metal trough for the calf, with an outer steel extending to the thigh, having a free joint at the knee: at the foot there is a metal sole-plate, movable by a single cog-wheel placed at the heel.

When the Scarpa's shoe is used, two cog-wheels should be placed opposite the ankle-joint, on the inner side of the leg, as shown in Fig. 476, as by this arrangement we have a greatly increased power of uplifting the outer margin of the foot, whilst the leg is drawn by the straps to the steel upright on the inner side. This stage will usually occupy from six to eight weeks, except in severe cases in adults.

The cases of talipes varus and equino-varus in which the treatment should be divided into three stages are those in which there is a marked degree of contraction of the plantar fascia, causing an increased prominence of the arch of the foot, by a movement of flexion and rotation inwards of the anterior portion of the foot, from the transverse tarsal joint. In these cases the head of the astragalus projects, sometimes conspicuously, on the instep, as this bone is partially extruded from the ankle-joint by contraction of the Achilles tendon behind; and the navicular bone is drawn downwards anteriorly, by contraction of the plantar fascia and muscles traversing the sole of the foot.

When division of the treatment into *three stages* is thus indicated by a severe degree of contraction in the sole of the foot, the object of the *first stage* will be to overcome all inversion of the foot, and reduce the varus, or equino-varus, into simple equinus. The *object of the second stage* will be to overcome the contraction in the sole of the foot, which generally necessitates a free division of the plantar fascia; and during the subsequent mechanical treatment, whilst the arch of the foot is being expanded by uplifting the metatarsal bones, the contraction of the Achilles tendon is of the utmost assistance, as it holds the os calcis rigidly fixed, and affords a point of resistance to the uplifting force exerted against the anterior portion of the foot.

This stage must be fully completed before the third stage is commenced, and will usually occupy a month in children, and from three to four months in adults. No greater mistake in treatment can be committed than to commence the *third stage*, the object of which is to cure the talipes equinus, by division of the tendo-Achillis before the second stage is completed, however long it may occupy. If any contraction in the arch of the foot remains when the Achilles tendon is divided, it cannot afterwards be corrected, and this defect will remain through life, in many cases leading to a relapse of the deformity.

The form of Scarpa's shoe best adapted to the treatment of these cases of equino-varus, and many cases of relapsed varus, is the modification of late years adopted by Mr. Wm. Adams, and represented in Figs. 476 and 477, in which the sole-plate is divided into two portions by a joint corresponding to the transverse tarsal joint, and the anterior portion can be moved in various directions by three rack-and-pinion movements in the sole-plate, as shown in Fig. 477; the movement of inversion and eversion is regulated at A, that of flexion and extension at B, and rotation at C, so that the anterior portion of the sole-plate D can be moved in any of these directions, the mechanical thus corresponding to the anatomical centres of motion in the production of the deformity.

Contractions of the Toes are not uncommon, and may be either

congenital or acquired, the latter being more frequent. The flexor tendons, or sometimes the digital prolongations of the plantar fascia, are implicated, resulting in the contraction or doubling up of one or more of the toes towards the sole of the foot. The second toe is most often affected, the first phalanx being slightly elevated, and flexion taking place at the junction of the remainder of the toe, with perhaps some overlapping of the adjoining toes. The great toe may be thrust outwards, and *extended* from the metatarso-phalangeal articulation, so as thus to overlay the second toe. Sometimes the little toe is similarly displaced. Both feet are not unfrequently affected symmetrically. Any such crippled condition is attended with lameness, and the more so owing to the co-existence of corns on the prominent points of the displaced toes. In the case of the great toe turned outwards, there will be an inability to stand on tiptoe, or to walk uphill; and the frequent association of a bunion is even more crippling. These contractions, or perhaps extensions, of the toes, with lateral displacements, are mostly produced by wearing tight or ill-made and hard-leathered boots. *Treatment*, therefore, consists in removing any such source of pressure—the patient wearing a loose, wide-made, soft shoe, and then the deformity may be rectified by counter-pressure. Contraction can be overcome by gradual extension of the toe; a digital whalebone splint is applied under the toe, and fixed by a narrow roller-bandage or strips of plaster. In children, this often proves sufficient. In adults, and with a more rigid state of contraction, the aid of tenotomy may be required, the flexor tendon being divided opposite the first phalanx or the process of plantar fascia, followed by the use of an extending splint. This must be worn for a few weeks to complete the cure. An extended state of the great toe will probably necessitate division of the extensor tendon; when the lateral divergence can be corrected by the patient wearing a wide shoe, having a partition between this toe and the next, so as to restore the right position.

Fig. 476.

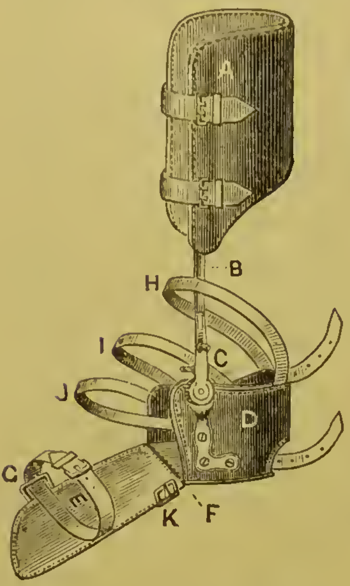
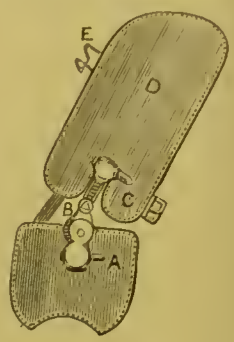


Fig. 477.



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